THE

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CONTENTS:

	PAGE
The Smoke Question in London	885
A New Circuit Breaker (*illustrated*)	887
The Swinburne Sulphide Ore Process	887
Electrical Canal Traction.—II.	888
Prof. Lodge on Space Telegraphy	889
Steam Engine Governors (*illustrated*) (*continued*)	889
Light Railway Schemes	891
The London County Council	891
Correspondence:—Brighton Breakdown	892
Combined Destructor and Electric Lighting Plants ...	892
Electrolytic Cyclic Process for the Treatment of Ores ...	892
The Burning Question	892
Single-Phase Induction Motors	893
The Burning (Steam) Question	893
Brighton Breakdown	893
The Institution of Electrical Engineers	894
Legal:—National Telephone Company *v.* Commissioners of Inland Revenue	894
Electric Construction Co. *v.* Imperial Tramways Co. ...	894
Savory *v.* Lloyd	894
Business Notices, &c.	894
City and South London Railway Extensions (*illustrated*) ...	901
Notes on the Relative Costs of Copper and Aluminium ...	904
Notes	908
City Notes	912
Traffic Receipts	912
Share List of Electrical Companies	913
Market Quotations	914
The British Association:—	
Experiments on the Influence of Electricity on Growing Vegetables or Plants (*illustrated*) (*concluded*)	915
The Institution of Electrical Engineers (*illustrated*) (*concluded*)	917
Accumulators at Hanover	919
New Patents	920
Abstracts of Published Specifications	920

THE

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THE SMOKE QUESTION IN LONDON.

SIR W. B. RICHMOND and a few faddists, with no responsibilities in the industrial world, who have been meeting at No. 6, Onslow Gardens, to call for a more rigid enforcement of the Smoke Acts, do not have to get their living by any business involving the use of coal. It is consequently an easy matter to get up in a West-End room and talk cheap philanthropy at the expense of hard working men. It is all very well, too, for others like Sir Jno. Brunner, who, exercising a huge monopoly on some cheap waste ground at Northwich, can easily afford to cover acres of ground with boilers, and keep his combustion rates at a low figure.

Sir Harry Poland contents himself with a bold statement, which he doubtless himself considers to be true, that London is worse than a third-rate provincial town. Lord Midleton takes up a prophetic vein, and wants future buildings not to emit smoke when science will step in, &c., &c. "That blessed leader" Mr. Ruskin, to quote Sir W. B. Richmond's own description, writes in his usual denunciatory style of that villain smoke, and the prime mover in this agitation thinks it encouraging to go on under his blessing. It is exceedingly kind of all these, no doubt, well-intentioned gentlemen, who know so little of the difficulties of manufacturers in London, to seek to harass them by ill-considered legislation. No one hates smoke more than we do ourselves, and we are by no means of opinion that everything has been done that can be done to diminish smoke. The fear of unreasonable smoke prosecution has been, more than anything else, responsible for the weak determination to use only smokeless Welsh coal. This course has had a double effect. It has raised the price of Welsh coal, promoted the Welsh coal strike, and brought London to its present pass of having very many boilers which are only fit to burn smokeless coal. If smoke prevention laws were enforced in a more rational manner, there would be some possibility of large fuel users experimenting with the means of perfecting their furnaces. Without doubt the smoke abatement question is important, and is worthy of fair consideration. Smoke inspection should be in the hands and under the control of gentlemen of scientific and practical attainments, who are capable of forming correct opinions upon the efforts put forward to cure the evil, and who can give sound advice on combustion. Equally important with smoke prevention is that of our national resources; our English coal is chiefly bituminous, and it is simply folly to cut off the use of the chief supply of coal from one-sixth of the people of the country. Yet this is the course advocated by drawing room faddists. That Sir W. Richmond does not realise the task he has undertaken is very evident, for he talks of the appointment of a *person* as smoke inspector. We would advise an engineer and gentleman who, whether well or ill paid, would not be open to bribery, which seems to be Sir W. Richmond's chief or

only reason for proposing good pay. Sir W. Richmond and his numerous and wealthy associates would be far better employed in promoting some means of electrical power transmission whereby London power users could buy energy manufactured miles away.

The principal producer of smoke in London is, however, the domestic fireplace. Our contemporary, the *Engineer*, does not seem to think that there is much smoke from domestic fires though, all the same, gas is advocated. The *Engineer*, however, appreciates the sentiment in favour of the open fire and bituminous coal, and scouts arguments deduced from practice in Russia, New York, or Berlin. We English do not require these foreign methods, chiefly because of the Gulf Stream's kindly consideration for these islands. Indeed, if we could all have hot air warming we should like an open fire in addition. We do not, however, agree with the *Engineer* that bituminous fuel cannot be burned smokelessly at higher rates than 8 or 10 lbs. per square foot per hour, and only then at an uneconomical rate. The classic Wigan coal trials proved quite the contrary, both in the rate of combustion and the evaporative efficiency. The *Engineer* states deliberately that no satisfactory means of burning bituminous fuel has ever been invented. This is too stringent. It may be difficult to obtain smokeless combustion, but it can be, and is done, with economy and efficiency, and would have been better and oftener done but for the methods of ignorant smoke inspectors, who have frequently not only threatened steam users with prosecutions during the process of experiment, but have actually carried the matter into Court. An experiment has proved a failure, for example, and for the rest of the day or week the output of smoke has been increased. This is not allowed for by the inspector, yet it is obviously impossible to attain success with every trial.

We have repeatedly advocated the policy of allowing combustion to become more perfect before absorbing so much heat from the furnace. The too rapid cooling of furnace products is responsible for smoke, and defeats the best efforts at air admixture and suitable draught. Lancashire boilers have the furnace well arranged for smokeless combustion, so far as mere form is concerned, but their furnaces are water cooled at a vital part. Water-tube boilers are often better in the latter respect, but are usually wrongly arranged in the former. The very varying rate of work at an electric light station is doubtless responsible for the trouble the electric light companies have been recently finding on the smoke account. The forcing of fires to get over the load curve peak with a reasonable fire grate area for all the other 23 hours or more of the day, is, we admit, a serious difficulty. It is got over usually by a 24 hours' use of Welsh coal. It might be worth while to consider the employment of Welsh coal for one hour with more forced draught, and the use of cheaper bituminous fuel for the remainder of the day. An ideal system of working a station over a peak is to have boilers of large water capacity at the feed level; to fill up the gauge glass to a maximum ready for the rise of the load curve; to check or stop the feed during the heavy period, and even call on the economiser for steam for a few minutes. Then, as the push slackens off, there is a low water level to be filled up, and an economiser of cooler water to absorb the surplus heat from the yet active fires as the load curve is returning to normal. So far, electrical engineers have chosen the exactly opposite system; they have selected boilers of small water capacity, which must be water fed through, or nearly through, the times of heaviest load; they have avoided the hot water reserve for the economiser, and have struggled through with a hand-to-mouth policy, which turns steam into the engines which has been produced by almost the previous shovel of coal. Vexatious interference from the *dilettante* of a West-End drawing-room will hinder the good work; let us have interference, but let it be rather from the engineers of a mutual association of steam users. It is from such mutual action that boiler explosions in England are less than in any other country, and that boiler making stands on a higher plane.

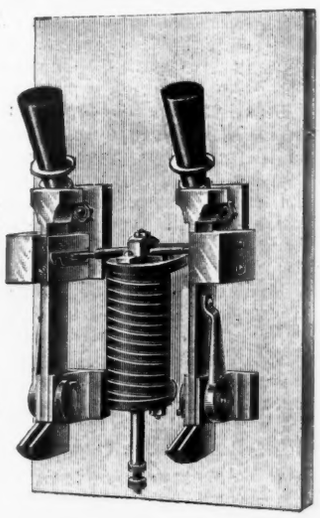
The smoke and combustion question would equally be best dealt with in a similar manner, under the guidance of some energetic engineer of practical experience and a sufficiently scientific and broad knowledge.

The Physical Society Meeting.

Dr. Chree's paper on the longitudinal vibrations of solid and hollow cylinders was read without discussion. Considering the wide range of application of his theorems, it is remarkable that his work should be received without comment; this circumstance suggests how convincing are his proofs, and how thorough is his grasp of this recondite subject. Most of us are content to take it for granted that the frequency of longitudinal vibrations for a thin rod is given by a simple expression involving nothing more complicated than the square root of the ratio of Young's modulus, to the density of the material. This expression is right enough for a long, thin, straight, homogeneous rod; but it does not hold for conditions outside that ideal case. When thickness is considered, it becomes necessary to take account of the fact that for every extension in the direction of the length there are stresses in the direction of the width, and the statement that higher harmonics are exact multiples of the fundamental frequency now fails. When want of homogeneity is also taken into account, together with the form and solidity of the vibrating body, and its surface conditions, the expression for frequency becomes far more complicated. Dr. Chree's paper is an investigation in detail of the general case. His work will no doubt be found to have an important bearing upon alternate current theory; for the formulæ relating to acoustics, alternate currents, and crank-shafts, have generally something in common. Incidentally he shows how the physical significance of a mathematical expansion is sometimes ruined by the whittling down of terms in the series, all for the doubtful advantage of simplicity; his remarks should be regarded as a caution by those who follow short-cuts unthinkingly. The second paper, by Dr. Young and Mr. Rose-Innes, is really a continuation of a study of Watt's indicator curves, in special cases, *i.e.*, for certain liquids obtained by the distillation of American petroleum. The particular substance now considered is normal pentane, this, if we remember rightly, is the illuminant adopted for burning in the standard "pentane" photometric lamp. Dr. Young has succeeded in obtaining *pure* normal pentane by the use of an ingenious form of fractional distillation apparatus. So far as we know, this is the first time that *pure* normal pentane has been produced in tangible quantities; we should therefore like to see a comparison of its value as an illuminant, with the "pentane" hitherto used in standard lamps. This pure normal pentane might turn out to be the most constant of all petroleum illuminants. Mr. Lehfeldt's suggestion of a curve-tracer is a good, but not altogether a new, one; he will probably find that the idea has been worked out in the *Zeitschrift für Instrumentenkunde*. The expense of such a machine would not be prohibitive if card-board scales were used; these would have less percentage error than the experimental divergences in Dr. Young's results, and plotting would be much simplified. Squared paper leaves much to be desired, but its defects are in most cases expiated by the circumstance that with it interpolation is easy and obvious. There are instruments which are instructive, but a nuisance.

A NEW CIRCUIT BREAKER.

The circuit breaker illustrated in the accompanying cut has many unique features. It is a double-pole device, having two blades which can fly out independently or simultaneously. The advantage of this arrangement, says the *American Electrician*, is that a short circuit cannot be thrown on the line without the interposition of a breaking device. One blade is thrown in at a time, and if a short circuit exists the first blade will be thrown out when the last is thrown in. The two cannot be thrown in at once, except by deliberate intent. Each blade has a separate latch and catch which acts on a roller principle, reducing the friction to a minimum. The hinged joint at the base of the blades carries on its pivot a nut which is connected by an arm to the blade itself. The closing of the blade compresses the clips of the hinge posts and improves the contact. It can be adjusted to any desired degree, and can be set to a pressure of



1,000 lbs. to the square inch if necessary. This makes the hinge posts even a better electrical joint than an independent jack-knife contact. The circuit breaker is equipped with a new style carbon break of liberal capacity, and so adjusted that the copper contacts separate over an inch before the carbons, which therefore take the entire arc. This effectually prevents burning of the clips. The solenoid is wound with two coils. They are formed of bare copper, and are carefully insulated between turns. The outer surface of the coil is turned and polished and presents a very fine appearance. The conducting parts of the circuit breaker are calculated on a basis of 750 amperes to the square inch. The range of adjustment of this instrument is from 100 to 400 amperes, and the normal capacity is 200 amperes. This circuit breaker is also made with under-load attachment. It is carefully calibrated, and said to be as reliable as any amperemeter on the market. Its installation on the switchboard is very convenient. Seven holes are all that are required to hold the circuit breaker in place on the board. These instruments have been used with great satisfaction on some of the largest installations in New York City. They are manufactured by F. A. LaRoche & Co., of New York City, and are known as the "Victor" circuit breakers.

THE SWINBURNE SULPHIDE ORE PROCESS.

We have received from Mr. James Swinburne a small budget of papers relating to the Phœnix Process (Parent) Company, Limited, a company which is being promoted with a capital of £50,000 in £1 shares. The objects of this company as set forth in the advance prospectus are:—

1. To purchase the Swinburne patents relating to the treatment of sulphide ores,

2. To procure the assistance of Mr. E. A. Ashcroft, late of the Sulphide Corporation, Limited.

3. To erect an experimental plant for trial of the Swinburne process upon an industrial scale.

4. To vend, lease, or otherwise dispose of, the Swinburne process, if proved an industrial success.

Of the proposed capital of £50,000, £26,500 is to be paid to Messrs. Swinburne and Ashcroft as vendors of the new process, £25,000 in shares and the remainder in cash; while the residue of the issue, £23,500, is to be used as working capital of the Phœnix Company.

At present, subscriptions are only asked to a preliminary experimental fund of £2,500 for further testing the value of the process. If these laboratory (?) trials are successful, the raising of the remainder of the cash capital, and the erection of the experimental works, will be proceeded with.

The process described by Mr. Swinburne in one of the printed papers accompanying the advance prospectus is as follows:—

The crushed (?) but unroasted sulphide ore is fed into an externally heated cauldron, containing molten lead and molten zinc chloride. The silver of the ore alloys with the lead; the zinc and lead sulphides mix with the zinc chloride, and form a molten mixture of chlorides and sulphides. After removal of the lead-silver alloy, the molten mass is electrolysed, and first the lead and then the zinc obtained in molten form at the cathode, while sulphur escapes as vapour at the anode. No chlorine is liberated, and the zinc chloride is finally recovered from the gangue, &c., of the original ore by distillation. Owing to the metals being separated at a temperature above their melting points, no difficulties arising from spongy deposits occur. The cost of operating the process is estimated at 38s. per ton of ore in Australia; or at 25s. per ton, if only the silver and lead be extracted. The English patents are 10,829 and 10,829A, of 1897; and patents in other countries have been applied for. Letters containing favourable expressions of opinion upon the process by Mr. Steinhart and Mr. Ashcroft are printed with the advance prospectus.

With regard to this process we may state that we thoroughly approve the cautious method of development which is being adopted.

The £2,500 for preliminary experimental work, and the £25,000 for a small industrial installation, compare favourably with the £10,000 and £250,000 spent in the trials of the Ashcroft process. We further think that the principle of the new process is a distinct advance upon the wet methods of treating these refractory sulphide ores; and we have long believed that if the problem of their successful treatment was ever solved, it would be by a fusion process, though not necessarily an electrolytic one. Whether Mr. Swinburne's process will be found both practicable and economical when tried on a larger scale remains to be proved; and if these trials end successfully it is necessary to remember that it will have to reckon upon the competition of the Fry process,* likewise a fusion process, which is about to be worked upon a very extensive scale at Manchester by the Smelting Corporation. We think that under these circumstances, the estimates of the cost by the Swinburne process will need careful revising. It is not sufficient to show that the treatment of the ore by this process leaves a large margin for profits and contingent expenses; it must be proved that the profits per ton of ore treated *equal or exceed* those obtained by the Fry process. We note that Mr. Swinburne, in the estimate of profits given in the advance prospectus, has calculated upon a 100 per cent. recovery of the silver, lead, and zinc contained in the ore. We consider this an altogether improbable return, when working upon a large scale; and shall doubt, until convinced by actual figures, whether even 90 per cent. will be attained.

Further, has Mr. Swinburne considered the time requisite to deposit the whole of the lead from a mixed mass of molten zinc and lead sulphides by electrolysis? Such operations, though theoretically possible, are difficult, even with the small amounts of material used for analytical purposes; and when one works with tons in place of grams, the difficulties increase. If the zinc sulphide is to be

* By this process, according to Ingalls, 90 per cent. of the silver, 87 per cent. of the lead, and 70 per cent. of the zinc are recovered. No electrical energy is required; the process is metallurgical.

wholly freed from lead sulphide, we anticipate that the cost of recovering the lead will be much higher per ton than that given by Mr. Swinburne's. If, on the other hand, the zinc sulphide is not freed from lead sulphide before passing on to the third stage of the process, the zinc deposited will be alloyed with lead and unfit for many purposes.

We make these criticisms not in hostility to the process, which we think on the whole a promising one, but in order to draw attention to those weak points in it, which will probably be revealed by the further trials, and will demand considerable attention if they are to be overcome.

With the copies of letters and other papers relating to the defunct Ashcroft process which have been sent to us under the same cover with the Phœnix Company's prospectus, we do not feel prepared to deal at length.

We are certainly surprised to see Mr. Ashcroft's name figuring on the front page of a prospectus before, in our opinion, he has adequately replied to the charges brought against him by his critics both in this country and in America; and we think that although the process, in the promotion of which he is now interested, is decidedly promising, he and Mr. Swinburne would have been better advised had they themselves provided the money required for the pending experimental work, and so avoided an appeal to the general public or to the shareholders in the Sulphide Corporation.

"Once bit, twice shy," is an old saying, the truth of which is frequently proved in financial affairs; and we shall be much surprised if it is falsified in the present instance.

ELECTRICAL CANAL TRACTION.

II.

The Bovet system consists of chains laid in the canal itself and simply carried over wheels on the barge, the barge mechanism being electrically actuated from overhead conductors. An ordinary chain is sufficient, and has the advantage that it will slip at times of abnormal stress and so obviate accident. The following formulæ are given for calculating an establishment of this type. Given T the annual tonnage in millions, K the journey of a boat in kilometres, and C the load of a boat. Then 300 C K represents the tonnage per kilometre. The number of boats in circulation per kilometre will be $n = \frac{10^6 \text{ T}}{300 \text{ C K}}$. Their headway in kilometres will be $e = \frac{600 \text{ C K}}{10^6 \text{ T}}$. Thus on a length of 60 k. the annual traffic being 3½ million tons, and the boats of 200 tons burthen, traversing 30 k. each, if the journey speed be 12 hours the velocity will be 2,500 m. per hour.

Each boat is estimated to require 3·2 kw. of energy or a total of 275 kw., or 535 H.P., allowing 91 per cent. output of generator. These values are arrived at from the formula $r = (a + b\,t)\ \text{v}^{2\cdot25}$ where v is the speed in metres per second, and t the draught in metres; r being the resistance in kilogrammes; a and b being—a 21·3, 21·5, and 14·2; and b 123·6, 78·1, and 52·4 for three classes of boat known in France as the *Peniche*, the *Flute*, and the *Toue*. The formula is applicable to speeds of ·25 to 2·5 m. per second, and draughts of 0·65 to 1·83 m.

It is advised that for steam power there should be a power station on each section. Gas engines, too, may well be divided up into several stations, and they have an advantage over steam for powers under 25 H.P. Oil engines are, unhappily, too costly to run, or they seem best suited to power distribution for canal traction purposes.

Phase currents are not new in industry. Why, it is asked, can they not be used in canal traction? The necessity for three lines need not be a serious disadvantage as is sometimes urged. The polyphase motor is so simple and strong as to demand serious consideration where it will be worked by men little acquainted with electricity. The polyphase system is more elastic and permits of a variation in the haulage as required, whilst on normal duty the speed is steady. Current is taken from the line by means of a two-wheeled carriage with a pendulum counterweight, the grooves of the pulleys being shaped to clear the insulators. The carriage is drawn by the boat by means of the cable which carries the current on board. The return current is not practicable by way of the tow chain. A second wire is therefore provided as return.

The carriage seems better than the fishing rod system, for a barge is not confined by a rigid rail and the arm must be long and very adjustable.

The use of accumulators does not seem to be very practicable for canal haulage. They are referred to as having been applied in England to pleasure vessels on the Thames, E.P.S. batteries of 44 to 180 elements being used according to the size of the boat, and double-bladed screws employed directly driven by four-pole motors excited in series.

A trial was made in France by the Société Boulet et Cie. Fifty-two Gadot cells were employed to work a Gramme motor equal to 100 volts × 41 amperes, with a three-bladed screw at 300 revolutions per minute. Speed trials showed 1 kilometre in 4 minutes 18 seconds, on a speed of 14 k. per hour. The battery gave 30 amperes in full discharge. At 80 per cent. efficiency the work performed was 3·25 H.P.

The *Gymnote*, a submarine torpedo boat of the French Admiralty, was tried in 1888 at Toulon. It had a four-bladed screw of 1·50 m. diameter. The motor was of 16-pole type. The poles were placed on a moving ring of 1 m. diameter, and furnished with a four-brush collector, two for forward and two for backward running. The speed was 250 per minute, and the screw was driven direct. The weight of the motor was 2,000 k. It gave 60 H.P. with a 200-volt current and 220 amperes. The battery was 564 cells of the liquid alkali type Commelin-Desmazures-Baillache. Each cell weighed 17·5 k., or a total of 9,840 k. for the whole. With a capacity of 345 H.P.-hours, sufficient for about a 6 hours' run, this means 28·6 k. per horse-power of charge. The speed for 6 hours would be 10 knots. Neither of these examples can be rated as commercial, however. For barge work the problem is quite different, and one must consider the question of the cost of loading and unloading the battery for charging, the shocks consequent on this and the damage to the cells, which rapidly deteriorate. It is, of course, easy to charge the batteries in place given time to do so. This should be done without unduly delaying their work and might be done by night.

Relatively to tramway work canal haulage is much easier for accumulators. The following figures may be studied:—A boat of 350 tons will run 4½ to 5 hours at 3 kiloms. per hour with a battery of a capacity of 110 ampere-hours weighing about 1,000 kilos., and measuring 1·42 m² × 325 mm. high. For a tramcar the battery will have a capacity of 180 ampere-hours and will weigh 1·750 kilos., and occupy an area of 2·16 m² of the same height—325 mm.—as the former. It is assumed that the weight of a battery in kilos. is a little over $\frac{1}{800}$th of its capacity in watt-hours. The displacement of a barge is, say, 339 tons, or 0·97 of the nominal 350 m³. At 3 kiloms. per hour its resistance may be taken as 0·37 k. per m³ of displacement. The total traction is thus 125 k. The work per second is 104 kgm. or 1,020 watts, or, say, 1,500 watts furnished to the motor. For a 6 hours' run the weight will be about 750 kilos. on the above rule. The rule is thus derived: Let I be the capacity of the battery, and I_1 its capacity per kilo. of plate. Then $\frac{\text{I}}{\text{I}_1}$ is the weight of plate per element. Add 0·65, then the weight in working order is $1{\cdot}65\ \frac{\text{I}}{\text{I}_1}$. At the tension E there will be $\frac{\text{E}}{1{\cdot}97}$ elements, whence the weight in kilos. is $\frac{1{\cdot}65\ \text{E I}}{1{\cdot}97\ \text{I}_1}$ for the batteries of the Société Electric. The current available is 15 ampere-hours per kilo. of plate, but only two-thirds this is guaranteed. For 10 ampere-hours, therefore, is found by substitution in the above formula 0·0838 E I.

As before stated, there is an electrical system on the Canal Bourgogne on a length of 6 kilom., of which 3,300 m. are in tunnel. This length is the summit level. It receives large quantities of water daily, at least 30,000 m³ in all seasons, of which 18,000 go to the lock at Pouilly and 12,000 to that at Escommes. At Pouilly there is a fall of 7 m. or 19 H.P., and at Escommes one of 8 m. or 15 H.P., a total of 34

H.P. Being similar, one only, that of Pouilly, need be described. The turbine is of Girard type, 1·16 m. in diameter and 100 revolutions per minute, geared to a shaft at 200 revolutions. It is regulated by a sluice electrically operated. The dynamos are of 11·6 and 9 E.H.P. of Gramme type. The ordinary work requires 370 volts (280 only at Escommes) or 23 amperes. The generators are in series and shunt wound because the employment of an accumulator was intended. The winding is condemned as causing great sparking, and if wound in series this fault would be absent, but it would be inconvenient for battery charging. Moreover, each machine tends to reverse the other's polarity.

At the time of starting a boat the turbines are only overcoming friction. By too rapid absorption of current at the motors, the turbines are overloaded and run slowly: as the fall at Pouilly is less than that at Escommes, the Pouilly dynamo is liable to be reversed in polarity. Frequent at one time they have been checked by a powerful rheostat of 180 ohms resistance so as to prevent too rapid admission of current to the motors. Slow movement of the rheostat enables the turbines to follow up their increased loading.

The advantage of the arrangement is that three conductors alone are required, one directly between the dynamos and two outer ones across which the motors work. The length of the electrical circuit is constant, and the current thus does not vary as the boat travels. Coupling in parallel would require four lines. Lower voltage is also possible with less line loss. The conductors are of telegraph bronze 8 mm. in diameter and of 45 kilos. per mm^2 tenacity, and 98 per cent. conductivity. The circuit resistance is 3·9 ohms. When under 600 volts the current is of 20 amperes. The fall of potential is 78 volts and the efficiency output 87 per cent. The conductors are carried by transverse iron carriers from posts. In the tunnel portion they are held by iron staples driven into the crown of the arching. They are hung by stirrups from the insulators. The middle wire simply passes over the throat of the insulators and is secured by brass wire. There is a tendency to sparking at the stirrups which have to be made thin to remedy this fault.

The advantages of the system are rapid erection, non-rigidity, absence of solder, different lengths being coupled by screwed bronze sleeves right and left threaded, the surface of contact secured being considerable, and they serve also to lengthen or tighten the line. Two trolleys are employed on a rod 7½ m. long, of which 4 m. is of iron tube, the rest being bamboo. The pulleys are protected by India-rubber guards against short-circuiting if derailed. The motor is of Gramme type, series wound. At 550 volts and 30 amperes it gives 19 H.P. at 900 revolutions. It is belted to the fly-wheel of the gearing, which is so arranged as to give a speed of 20 or 40 to the chain wheel, corresponding to a rate of travel of 0·65 or 1·30 metre per second. The chain runs in the middle line of the barge. The barge is lighted as it passes the tunnel by two series of lamps, arranged that as the rear lamp is extinguished a fresh one lights up, the length of the barge being thus constantly illuminated. The accumulators contain 250 elements. Their normal capacity is 15 amperes discharge rate and 10 amperes charging. The battery is shunt connected to the line, and serves as a steadier, not being required as a store, for there is no lack of water. It is placed at the generating house, though formerly it was on the towing vessel, and caused damage by acid vapours. For a period of six months the cost of transport has been 0·071 franc per ton, or about ¾d., showing an economy of 30 per cent. over steam towage at 0·103 franc. The air of the tunnel is, of course, no longer rendered suffocating by the smoke of coal, and the speed obtained is good.

PROF. LODGE ON SPACE TELEGRAPHY.

Prof. Lodge's lecture at the Institution of Electrical Engineers on "Improvements in Magnetic Space Telegraphy," is more than a description of a new system, it is a criticism of old methods and a study of their limitations, followed by a look ahead into the possibilities of ship and shore signalling. To begin with he gave his hearers a careful explanation of the difference in quality and function between the magnetic induction exerted between wire and wire, as in the Lavernock experiments, and the progressive waves that are emitted by a Hertz oscillator. The distinction between the two kinds was illustrated by the case of a magnet "wobbled" slowly on one side of a sheet of copper, in which case a compass-needle on the other side of the sheet is affected; and a magnet "wobbled" fast, in which case the needle does not respond. A magnetic alternation of sufficient rapidity induces an alternating electrostatic field, and is therefore accompanied by emission of energy; but a slow magnetic alternation is practically unaccompanied by electrostatic effects, and practically all the energy emitted at each pulsation returns to the source.

The new system of telegraphy, now suggested by Prof. Lodge, is the outcome of his well-known experiment on "tuned" circuits, where two similar Leyden jars, each provided with a suitable metallic circuit, are made to respond to one another at a distance. Instrument makers were reminded that when they design the apparatus for this experiment, the *areas* of the resonating circuits should be carefully attended to; as a rule they are made too small and too cramped; all the joints should be soldered, and chains, "which are an abomination," should be avoided, the circuit should be so well jointed that a thermopile will send an appreciable current through it. In the experiments on signalling, the Leyden jars are replaced by condensers of several microfarads capacity; the resonating metallic loops are enlarged into inductive coils of great area arranged horizontally; and the influence machine gives place to an alternate current dynamo. Lastly, the receiving apparatus is geared up by a train of telephonic relays, so that the diaphragm of the last telephone of the train vibrates with sufficient violence to make an electric contact, which in turn can operate a telegraphic instrument.

The discussion on the lecture promises to elicit some important information with regard to the effect of sea-water on the attenuation of electric waves. This question has been gone into mathematically by Mr. Whitehead in a Physical Society paper. He finds that the loss due to 20 miles of traversed sea-water is 79 per cent. of the initial electric impulse. Prof. Lodge seems rather unwilling to accept these figures; his objection is based on the assumption that the re-acting currents, which are really responsible for the attenuation, are, at considerable distances from the source, extremely feeble. According to Prof. Lodge, the only conductors that interfere between the primary and secondary coils, in such a case, are such as have a position near one or other of the coils. A single conductor exerts its greatest obstructive power when it is placed half-way between the primary and secondary coils; but if the coils are far from one another, the effect, in Prof. Lodge's opinion, is almost negligible. Moreover, he points out that Mr. Whitehead's calculations appear to be developed from differential equations which assume that the sending circuit emits *true* waves. And while it is the fact, as demonstrated by Prof. J. J. Thomson, that a Hertz oscillator in a trough of liquid has its oscillations absorbed with great rapidity, the same does not necessarily hold for a simple fluctuating magnetic field. Prof. Lodge suggests that the sea-water question might be compromised by putting one horizontal coil on shore, and another, in the same plane with it, on the ship.

STEAM ENGINE GOVERNORS.*

By JOHN DAVIDSON.

(*Continued from page* 806.)

As the automatic expansion governor driving the steam distribution valve direct in the case where only one valve is used, has the effect of causing a much more unequal turning effort to the crank than when a throttle is used, I have prepared diagrams showing the fluctuation of energy per revolution of a single cylinder horizontal engine under different conditions of governing and when running at various loads. The coefficient of fluctuation of energy per revolution in each case being given in the table.

* Paper read before the Salford Science Students' Association at the Royal Technical Institute, Salford.

The conditions of load are as follows:—

The full load with the automatic expansion engine is taken at 3 of the stroke. With the throttle engine the cut-off is taken at ·35 of the stroke to allow for a little overload or drop in steam pressure. With the two-valve automatic the steam admission was the same as the one valve, but the release and compression under the same conditions as the throttle engine. Boiler pressure, 100 lbs. per square inch. The effect of the inertia of the moving parts being taken into account in all cases.

Coefficient of Fluctuation of Energy per Revolution.

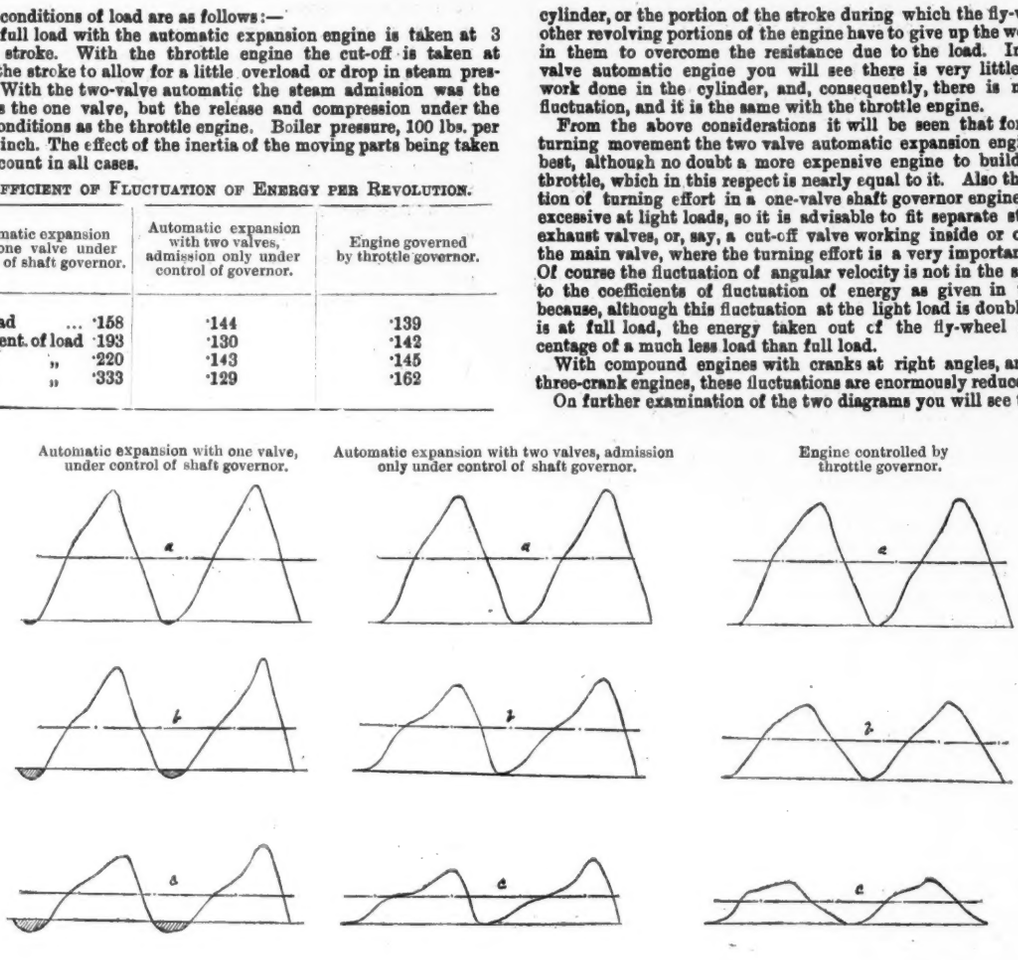
Automatic expansion with one valve under control of shaft governor.	Automatic expansion with two valves, admission only under control of governor.	Engine governed by throttle governor.
Full load ... ·158	·144	·139
60 per cent. of load ·193	·130	·142
40 „ „ ·220	·143	·145
15 „ „ ·333	·129	·162

cylinder, or the portion of the stroke during which the fly-wheel and other revolving portions of the engine have to give up the work stored in them to overcome the resistance due to the load. In the two-valve automatic engine you will see there is very little negative work done in the cylinder, and, consequently, there is much less fluctuation, and it is the same with the throttle engine.

From the above considerations it will be seen that for an even turning movement the two valve automatic expansion engine is the best, although no doubt a more expensive engine to build than the throttle, which in this respect is nearly equal to it. Also the fluctuation of turning effort in a one-valve shaft governor engine is rather excessive at light loads, so it is advisable to fit separate steam and exhaust valves, or, say, a cut-off valve working inside or on top of the main valve, where the turning effort is a very important matter. Of course the fluctuation of angular velocity is not in the same ratio to the coefficients of fluctuation of energy as given in the table, because, although this fluctuation at the light load is double what it is at full load, the energy taken out of the fly-wheel is a percentage of a much less load than full load.

With compound engines with cranks at right angles, and also in three-crank engines, these fluctuations are enormously reduced.

On further examination of the two diagrams you will see that with


Automatic expansion with one valve, under control of shaft governor.
Automatic expansion with two valves, admission only under control of shaft governor.
Engine controlled by throttle governor.
a
b
c
d
a = Full load.
b = 60 per cent. of full load.
c = 40 per cent. of full load.
d = 15 „ „ „
——.——. = Mean effective turning effort at the crank.
———— = Zero line, or where crank effort is nil.

Diagrams showing Effective Turning Effort during One Revolution.

With the one-valve engine worked by a shaft governor, the fluctuation increases from ·158 at full load to ·333 when running at the light load. When two valves are used the fluctuation varies very little, being a little less at the light load than the full load. In the case of the throttle the fluctuation does not alter very much, being a little more than the two-valve expansion engine.

If you examine the indicator diagrams, figs. 1 and 2, you will see that the principal cause of the fluctuation is due to the compression.

Fig. 1.

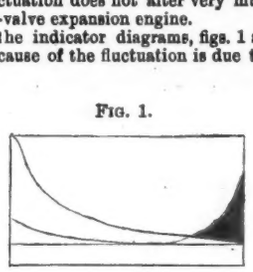


Fig. 2.

Fig. 1 represents a light load card of a one-valve variable expansion engine, corrected for effects of inertia of the moving parts, and showing the effective pressure per square inch of the piston to turn the crank; and fig. 2 a similar card of a two-valve variable expansion engine. The shaded portion shows the negative work done in the

the variable expansion engine even at light loads, the engine has to withstand the full boiler pressure, and in the case of the throttle the maximum pressure may be only one quarter of the boiler pressure or less. Owing to this fact the throttle engine is subject to much less wear and tear than the variable cut-off at light loads.

In deciding which kind of governor to adopt for an engine, then, there are several things to consider, as one cannot say haphazard that for all purposes the variable expansion governor should be used, and is the best in every way, although as a speed regulator purely, as I have already mentioned, it is, beyond all question, the superior.

Again, by providing excessive fly-wheel power to an engine, you may cause it to turn with a very even angular velocity, and you might go on adding till you got the fluctuation hardly perceptible. This would mean very large bearings, and would tend to reduce the mechanical efficiency of the plant, but beside this it would have its effect upon the governor. A sudden change of load would not cause the engine to gallop away or pull up so suddenly, but it would be longer in again settling, and the oscillations in the governor, if any take place, would be longer, consequently a very sensitive governor will be required.

In gas engines, where there is only one impulse every two revolutions of the crank, very large fly-wheels are fitted, to counter-balance the unequal crank effort; but in the case of steam engines, where it is possible to get a fairly even turning effort by properly arranging the steam distribution and cranks, there is not the same need of them.

In controlling the speed of an engine there are three variations which the governor has to deal with, viz., first, sudden changes of load; second, gradual changes of load; third, alteration of steam pressure.

The quickness of the action of the throttle governor depends not only upon the design of its mechanism, but also upon the steam space or volume between the cylinder valve and the throttle valve, for whatever steam is between these two valves when a load is thrown off, it is beyond the control of the governor, and may have a serious momentary effect. Therefore, for the best results, the throttle valve

must be placed as close as is practically possible to the cylinder valve.

A change of load on an engine governed by variable expansion is met by an earlier or later cut-off of the steam admission to the cylinder, consequently the steam already in the cylinder is all that is beyond control when a load is thrown off suddenly, and even then, if there is only one valve to the cylinder, and the governor is sufficiently sensitive the compression will be increased and tend to keep back the engine. In a compound engine with both cylinder valves under control of the governor, the effect of the steam in the receiver will be reduced by the cut-off in the low pressure cylinder being altered also, and this will put more back pressure to the high pressure cylinder. On account of the immediate action of the variable expansion governor upon the cylinder valves, it is more prompt in answering to a change of load, and where sudden changes are expected, this governor is preferable to the throttle.

For a gradual change of load, or an alteration of steam pressure, both governors can be made to answer equally well in keeping the engine speed constant, or within the limited permanent variation, if they are properly designed.

It is not possible to keep the speed exactly constant during the changes in load, &c., even with the most sensitive governor, because the governor itself cannot act until some slight change in speed has taken place, as it cannot anticipate a change of load. Therefore, if you take some load off an engine, it must actually gain speed a little before the governing mechanism can come into play, and alter the quantity of steam being supplied to the engine, to an amount just sufficient to keep the engine in motion at the normal speed.

This variation may be only momentary, and the more sensitive to a change in speed the governor is, the less will this variation be; but when the governor had settled in its new position, the speed would then be the same as with the heavier load. The governor that will do this perfectly, and remain satisfactory, has yet to be invented, and for most purposes is not required; yet with some forms of governors it is possible to keep within very small limits of the normal speed at all loads.

The permanent variation is required to be kept very small for some engines, or in other words, the speed the engine runs without any load, or simply turning itself, must not be more than from 1 to 2 per cent. more than when running with the full load on. Also, for good governing, it is essential that the momentary variation caused by sudden changes of load should be as small as possible, and with a perfect governor, this would exactly correspond with the permanent variation. A perfect governor does not necessarily mean one which will keep the engine at exactly one speed for all loads. Suppose you design a governor so as to cause an engine to fall in speed, say, 3 per cent., when the full load is put on. As the engine falls in speed, due to the extra work put upon it, so would the governor take up a new position, and when the engine had dropped 3 per cent. in speed, or had full load on, the governor would have moved at the same instant, to such a position as to give sufficient power in steam to the engine to do full load. In this case there would be no extra momentary variation, because, as the load changed, so would the governor with it to correspond. In practice, of course, this is impossible, as the change in speed of the engine takes place first, and this change causes the governor to alter, and prevent any further development of the variation.

The quicker the governor answers to any fluctuation in speed, or the more sensitive the governor is to small fluctuations, the less will this momentary variation be.

Again, all the forces of the governing mechanism must act in harmony when a variation takes place to make it quick in acting, and the various joints, &c., must be as free from friction as possible, this depending a great deal upon the design of the mechanism, for supposing the forces in the governor tending to alter the position of the gear to be moved, have to exert a big force to overcome the friction of its joints alone, an unnecessary large variation in engine speed would have to take place before the governor moved, and then it would move too far, and cause a fluctuation the opposite way, and so on. Friction has an evil effect on all governors, so for good governing it is absolutely necessary that the friction of the various joints be reduced to a minimum. Now the forces in the governor have to overcome the friction, &c., of the gear it has to move to control the steam supply, and this consideration determines the power required, and settles the weight of its parts, &c.

With a throttle governor, generally what the mechanism has to do is to move a balanced valve of light construction, and requiring very little power to move it, especially when a combined governor and throttle valve is used, which means a moderate-sized governor will do the work, depending upon the speed, &c.

(To be continued.)

LIGHT RAILWAY SCHEMES.

November 30th was the last day for lodging before the Light Railway Commissioners statements of proposals to take advantage of this cheap and quick way of obtaining powers to run light railways through England, Scotland, and Wales. The new procedure is evidently now in working order, and the number of applications is remarkable compared to previous years. The specifications lodged in accordance with the statute show that the railways and electric communications by rail now contemplated will reach a length of nearly 500 miles, at a cost of over £3,300,000. There are 54 projected lines, of which Wales has only three, and Scotland nine. Electricity is coming rapidly to the front, and in the 54 cases lodged 32 are electric traction.

The following is a list, published in the *Pall Mall Gazette*, of the new lines projected:—

Name.	Mileage.	Motive power.	Estimated cost.
England.			£
Aldershot and Farnborough	5¼	Electric	64,093
Axminster and Lyme Regis	6⅜	Steam	49,938
Barnsley and District	3¼	Electric	22 351
Callington	11	Steam	99,792
Camborne, Redruth and District ...	10	Electric	41,887
Cawood, Wistow, and Selby (Extension)	4½	Steam	18,541
Cheltenham and District	5¾	Electric	46,587
Colchester	5	„	33,327
Colne and District	5½	„	81,614
Corringham	2⅜	Steam	5,474
Cranbrook, Tenterden, and Ashford ...	12	„	120,925
Crystal Palace	9½	Electric	45,417
Didcot and Watlington (Extension) ...	2⅜	Steam	25,960
Doncaster and District	5½	Electric	37,324
Doncaster Corporation	7½	„	34,500
Dudley and District (Extensions) ...	3¼	„	27,277
East Anglian	3⅜	„	98,912
Essington and Ashmore	5½	Steam	56,376
Finchley, Hendon, and District ...	10¼	Electric	111,185
Gosforth and Ponteland	7	Steam	33,398
Hampstead, Finchley, &c.	14½	Electric	75,615
Hastings, Bexhill, and District ...	13½	„	63,524
Highgate, Finchley, and Wood Green	10⅜	„	54,559
Hounslow and Twickenham	6⅜	„	47,259
Isle of Thanet (Extensions)	5¾	„	23,224
Land's End, St. Just, &c.	20½	Steam	146,148
London United Tramways, Limited, Light Railway Extensions	16⅜	Electric	199,045
Middlesbrough, &c.	7	„	56,340
Middleton (Extension)	2	„	15,108
Nelson and District	1½	„	15,000
Nelson, Colne, &c.	6¼	„	87,860
North Lincolnshire	35¼	Steam	137,433
North Lindsey	14½	„	80,282
Nutley, Crowboro', and Groombridge	11	„	56,666
Orpington, Cudham, and Tatsfield ...	7⅜	„	69,254
Penzance, Newlyn, &c.	21	„	152,246
St. Helens, Leigh, and Bolton	24	Electric	102,090
Southend-on-Sea and District	6¼	„	40,474
South Staffordshire	4¼	„	28,767
Spen Valley	7½	„	55,631
Trent Valley (Amending)	15	Steam	81,250
Waltham Cross and Enfield	5⅜	Electric	27,923
Wales.			
North Wales Narrow Gauge Railways (Beddgelert Extension)	4½	Steam	11,496
Rhyl and Prestatyn	3⅜	Electric	26,458
Swansea	7½	„	55,172
Scotland.			
Ayr, Prestwick, and Monkton	4⅜	„	31,787
Caledonian (Avondale)	7	Steam	39,997
Glasgow and S.W. Railway (Cairn Valley)	15⅜	„	165,840
Hamilton, Motherwell, and Wishaw ...	8¾	Electric	79,532
Inverness and Loch End	7½	Steam	46,776
Musselburgh	4½	Electric	37,303
Ruins of Galloway	20	Steam	97,384
Uphall and Bangour	1⅜	„	10,243
Wick and Lybster	13½	„	71,949
	492½		£3,344,563

LONDON COUNTY COUNCIL.

It was reported by the Finance Committee at the weekly meeting of the Council on Tuesday that a loan of £10,470 to the Shoreditch Vestry had been completed for electric lighting purposes. It was decided, on the recommendation of the Finance Committee, to lend £11,020 to the Hammersmith Vestry for the extension of the electric light installation, and £10,000 to the Newington Vestry for electric lighting purposes. In the latter case, which relates to the second instalment of a total sum of £50,000, the repayment of the capital will be deferred for the first three years and spread over the remaining 39 years of the currency of the loan.

The Telephone Question.

The Highways Committee submitted an adjourned report relating to the overhead telephone wires in the district of Islington. The Committee recommended that the National Telephone Company should be permitted to continue

certain overhead wires, the length of which exceeds that stated in the Council's bye-laws, for periods ranging from six to 12 months. Colonel Ford move that the recommendation should be referred back to the committee for further consideration. He thought that the Council should pause before it threw up the sponge and yielded to the company. It was stated by the press that on the Glasgow Corporation deciding to promote a Bill to obtain powers to establish a telephone system, the company had at once agreed to reduce its rates by one-half. It was therefore not desirable to hurriedly give the company the permission asked for. Mr. Torrance seconded the amendment. Mr. Howell Williams, as one of the members for Islington, said that the question had not been finally settled between the Vestry and the National Telephone Company. The Vestry desired the Council not to decide the matter either one way or another, but to defer the consideration of the question for that day. If the report was adjourned it would strengthen the position of the Islington Vestry in arriving at a final understanding with the telephone company. Mr. J. W. Benn, chairman of the Highways Committee, said that he was willing to take back the report, the consideration of which was accordingly adjourned until after the recess. It was decided to give permission to the National Telephone Company to lay eight additional lines of pipes underground between the Northumberland Avenue and the Victoria Embankment subways in connection with the company's cables in those subways, the company to pay £1 1s. per annum for each of the eight lines of pipes.

THE TRAMWAYS ENGINEER.

A surprise was sprung upon the Council in an urgency report of the Highways Committee stating that a letter had just been received from Mr. John Young, of the Glasgow Corporation tramways, declining to accept the position of chief officer of tramways to the County Council, as conferred upon him by the resolution passed on 29th ult. In the course of the letter Mr. Young said that, after investigation of the question, he found the position would be so difficult from what he had anticipated, and from what he had long been accustomed to, as to render it impossible for him to accept it. Under the circumstances, and in view of the necessity for making provision for the administration of the tramways, the Highways Committee recommended that Mr. Alfred Baker, of the Nottingham Corporation tramways, should be appointed manager of the tramways at a salary of £1,000 a year. After considerable discussion the proposal was agreed to.

It may be mentioned that the appointment of Mr. Baker, as manager, still leaves open the question of a chief officer of tramways.

OVERHEAD TRAVELLER.

It was decided to issue advertisements inviting tenders for the supply of a 5-ton overhead traveller at the new pumping station at North Woolwich.

CORRESPONDENCE.

Brighton Breakdown.

I think the cause of the automatic minimum switches cutting out the machines can be traced to a far simpler source than suggested by "H. C. L." The characteristic curves and the demagnetising action of the armatures do not seem to come in at all.

"H. C. L." says: "A properly designed shunt dynamo, if run up to speed with its terminals short-circuited (*and therefore giving no volts*) will, if the resistance between the terminals be suddenly increased to its normal full-load value, immediately take on its full output more or less rapidly." This, of course, is true enough, but I would like to emphasise the "more or less." It must be remembered that at the moment of removing the short-circuit the machine is giving no volts, and therefore there can be no current to hold on the minimum cut-out, hence the machine must be cut out of circuit.

This would be still more marked if accumulators are used in parallel, as they would recover far more rapidly when the short is removed, than the shunt machines, in fact, if the cut-outs do not drop, a current would probably be flowing from the accumulators into the machines.

A. D. C.

Combined Destructor and Electric Lighting Plants.

I have read with interest Mr. E. K. Scott's article on this subject in your issue of yesterday.

May I suggest that when next Mr. Scott lays himself out to indite "morals" and "conclusions" he will not confine his inquiries to one much-criticised plant, but will endeavour to ascertain whether there is really such a depth of ignorance among consulting engineers and contractors as he appears to predicate?

If we start with the assumption that the destructor is going to be of modern construction, and capable of being worked without nuisance, the same arguments as to situation apply to the destructor as to the lighting station—the one should be central to save distribution losses, the other to save collection and cartage cost. As regards staff, there is nothing unreasonable in giving one chief engineer charge of the combined plant, and making one set of clerks weigh materials and calculate and pay wages for the whole. No one proposes (*pace* Mr. Scott) to send "a navvy from the destructor" to the switchboard, because the navvies (*alias* stokers) are fully and constantly employed at their own work. The suggestion that any manager of such a combined plant would endeavour to keep down his costs by keeping down his output, should not have come from a gentleman with any pretentions to electrical knowledge.

In his "conclusions" Mr. Scott goes out of his way to tumble over difficulties, which have been fully considered and are easily met.

In all electric light stations, stand-by boilers have to be provided; the simple plan is that adopted in many schemes for which my firm contracts at the present time; a sufficient number of boilers with ordinary furnaces are provided for the requirements of the electric lighting station, and arrangements are made for leading the destructor gases into some or all of those boilers. The boilers are placed in batteries, so as to be readily and economically fired with coal if required; and my experience of working destructors is that the steam can be kept at a constant high pressure with much greater ease than is the case with ordinary boilers, owing to the large reservoir of heat in the brickwork of the destructor flues, and owing to the fact that a number of cells are charged and clinkered in regular rotation.

The engine house is, of course, carefully isolated from the destructor and boiler house, and thus the whole benefit of the heat from the destructor is obtained, with none of the inconveniences which worry Mr. Scott.

F. L. Watson, A.M.I.C.E.

The Horsfall Furnace Syndicate, Limited, Leeds.
December 12th, 1898.

Electrolytic Cyclic Process for the Treatment of Ores.

Writers of articles on electrolysis ought, above all, endeavour to avoid the use of incorrect terms and misnomers.

I object most particularly to the expression, *electrolytic cyclic* treatment of refractory ores; first, because electrolysis has *nothing* to do with the refractory *ores*, which are not treated by aid of the electric current. The electrolytic treatment applies only to the solution, after the ores, refractory or not, have been leached.

Second, because I do not see any *cycle* in that very simple electro-deposition of zinc from a sulphate solution. Ten years ago, Hermite claimed that his electrolysis of chloride of magnesium was a perfect cycle, in which the chlorine spent in bleaching was recovered by passing again the electric current through the same solution.

Is there any recovery in the electrolysis of the bath described by Mr. Cowper-Coles, which justifies the employment of the expression, "cyclic"?

I have stated that I do not see any difference between the rotating discs used since several years by Dr. Tommasi for the deposition of lead, zinc, &c., and the revolving discs adopted by Mr. Cowper-Coles. So much the better for him if he has been the first to deposit metal on revolving discs; it is for him to prove it.

Cyclist.

The Burning Question.

Your indictment of Mr. H. E. Kershaw in the later number of your journal not only attacks him in an unjournalistic manner, but reflects upon the common sense and perception of the 120 gentlemen that form the Shoreditch Vestry, and, being one of that number, I feel that I am under your ban, and though I know Mr. H. E. Kershaw to be thoroughly able to answer for himself, and also to have the warm support and approval of every loyal man on our board, there is one part of your last article he may not mention

that warrants a reply. You say "it would be interesting to know why Mr. Kershaw's statements at the opening ceremony was 1s. 2d. per ton and now 2s. as the cost of burning, for in his speech at the Vestry meeting he tells us his figures had proved to be erroneous," &c., &c.

Now, Sir, this is not fair; it's only half the truth. Your reporter was there, and should, to be just, have given the rest of Mr. Kershaw's speech, which another journal, not so prejudiced, quotes as follows:—

"Mr. Kershaw explained that in the interest of labour the Vestry immediately they took over the plant increased the contractor's cost one-third by an act of humanity that abolished the two 12-hour shifts that was prostrating the men, and commenced with three 8-hour shifts and three additional men."

This, Sir, answers your point, although you must have known it when you wrote your article. My object in writing would not be accomplished were I not to say yours is the only electrical journal that has taken this view of our scheme, all the others, which are eagerly scanned at our beautiful public library, congratulate us on our magnificent success.

W. Johnson.

Single-Phase Induction Motors.

It is indeed gratifying to the English electrical engineer to learn that single-phase induction motors are at last being "made in England." I fancy, however, a smile of amusement must have passed across the faces of some of our Continental neighbours as they perused the issues of the English technical papers of the week before last, to see how much attention was paid by two of our leading journals to a little 25 H.P. single-phase induction motor.

You remark that the Langdon-Davies motor (which is admittedly one of the only makes of English single-phasers) may now be considered "out of its swaddling clothes," speaks volumes for the lamentable prejudice and unwarrantable ignorance displayed by the engineers and professional men of our own country regarding what has been done for years in this line on the other side of the Channel. It really points out that we in England, in 1898, are turning out single-phasers, the largest of which is less than one quarter the capacity of those manufactured on the Continent in 1894. Might I mention that Brown, Boveri & Co. delivered in January, 1895, a 110 B.H.P. single-phase induction motor to Intra; that at present there are quite a number of units of sizes from 40—90 B.H.P. running in Frankfurt (there being, as Mr. Levin pointed out through the medium of your columns in the issue of November 25th, an aggregate of 1,400 H.P. connected to the mains of the Frankfurt Electric Supply Company alone), and, further, that Messrs. B. B. & Co. delivered in 1894 two 30-B.H.P. 100-cycle induction motors for running off the mains of the Worcester Supply Corporation.

Recognising, as do all central station engineers, the supreme importance of increasing the load factor of their station, how is it that they are only now making the discovery that there has been for years an inexpensive and practical single-phase motor on the market?

One other question—How about multiphase motors? How many years will elapse before an English engineering firm will turn out a 1,000 B.H.P. induction motor such as was illustrated in one of last week's issues?

M. B. Field.

The Burning (Steam) Question.

Since your spiteful attack under a not very courteous headline, "What happened to Kershaw," I have been anxiously waiting for the promised analysis of our trading account, and, although I do not lay claim to be an electrician, I think I can cross swords with you, Sir, in compiling accounts.

I shall not trouble myself about answering any of your sarcasm, as any intelligent reader can read between the lines of all that, but to give your readers some little idea of the "fairness" with which you treat an opponent, I will just give one illustration. In your verbatim report of the proceedings of our Vestry when these accounts were submitted, you generously quote my opponents' views in full, laying particular stress on their most salient points, but my reply, which completely smashed the whole of the opposition—or what you term "eating humble pie in large mouthfuls"—you ingeniously leave out my most pointed facts. An instance: You state that the accountant was instructed not to make any alterations, and that he denied he had audited the accounts. Why did you leave out my reply when I produced to the Vestry his own figures and his own letters, in which he distinctly stated that he had audited the accounts, and that no such remark had ever been made to him, but that he was told not to treat it as a balance sheet and bring forward items entirely extraneous to a trading account? This, Sir, is a fair specimen of how I should reply if I took your article paragraph by paragraph.

But now for your finances. You make us a net loss of £68 17s. 11d. You give us no credit for the saving of £1,253 on the old system of barging, and you charge on our destructor account £1,435 13s. 4d. interest and repayment of capital. This is grossly unfair, and, as you know, I stated so at the Vestry, when I pointed out that if this item was to be charged to the destructor, then interest and capital on the buildings and the wharf at the Scavenging Department should also be taken into account.

It is true you note, in a way, that the repayment, interest and capital, on the electric lighting undertaking, £2,641 16s. 2d., is a debit. But suppose this to be a public company, these two items would be available for dividend, total about £4,000.

I will leave it to the intelligence of your readers to work out these figures for, take them how they will, the result is a phenomenal success of a phenomenal undertaking; but in your desire to discredit a successful scheme you lose sight of the most important point, and that is, that we are a sanitary authority. We are under an obligation to dispose of our refuse. We were formerly in the hands of a ring of contractors, who charged us as much as 3s. 5d. per ton for what my department is now charging 2s., and if the whole thing did not produce a single penny profit we should have been more than justified in its establishment, and whatever strictures we may have to put up with from the ELECTRICAL REVIEW, we are gratified in knowing that among the whole technical press you stand alone.

H. E. Kershaw,
Chairman Electric Lighting Committee
Shoreditch Vestry.

129, Curtain Road, E.C.,
December 12th, 1898.

Brighton Breakdown.

Your correspondent "H. C. L." quarrels with my statement with reference to the fact that the study of the curve in question suggests a satisfactory explanation of the above.

Surely the quarrel is only one of definitions, as, of course, my intention was that the curve should be studied in conjunction with the *actual* facts.

He makes the suggestion that the limiting value of the current was momentarily greatly increased by the sluggish response of the large magnets, and the momentum of the moving machinery, or, in other words, that the characteristic curve was momentarily greatly extended. This seems obvious.

He makes the further suggestion (previously made) that the reduced E.M.F. on the field coils, and the increased demagnetising action of the armature may have reduced the magnetic flux to zero, and even reversed it.

Does not the characteristic curve owe its shape mainly to these two courses, and therefore afford the means of predicting the resulting loss of field.

I still maintain that a shunt machine (or machines), running at considerable load and therefore with the brushes well forward, if short-cicuited sufficiently long for the demagnetising ampere-turns in the armature to overpower those of the field coils, before the short is removed, will run down to zero, and will not re-excite on load until the brushes have been brought back at least to the zero position.

This statement has been verified repeatedly in my own experience and also that of others, and is therefore not a question of theory only.

Apologising for again trespassing on your valuable space.

Wm. C. P. Tapper.

D

To A.B.C.—First question: of course they can! Second: In the diagram you give the middle wire is neutral.—Eds. Elec. Rev.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution of Electrical Engineers on Thursday evening last week, a large and enthusiastic audience attended to hear Prof. O. J. Lodge read his paper on "Improvements in Magnetic Space Telegraphy." Dr. Lodge improved upon the usual method of reading the paper as printed, by giving what was, to all intents and purposes, a succinct and interesting account of electric and magnetic space telegraphy, and proceeded to illustrate his method by several experiments, which took his hearers by storm. A series of lantern slides cleared up the few points which were not quite clear, such as the construction of his novel magnifying telephones.

Amongst the many attractive features of his discourse—which resembled more a Friday evening entertainment at the Royal Institution than a prosaic Inst. E E. gathering—were the condemnation of chains in Leyden jars as "an abomination"; the application of the syntonic Leyden jar experiment to telegraphy—the true subject matter of the paper—and the clear manner in which, by the aid of the blackboard, the effect of capacity and inductance in mutually annulling one another were demonstrated.

Dr. Lodge's humorous account of his Liverpool experiments with a "howler" was far and away more amusing than much that passes for harmless fun in the comic papers, and we regret that it is impossible to reproduce in print the telling way in which the novel and catching points in the paper were put forward without use of the printed matter.

On conclusion of the experiments and illustrations, Mr. Preece rose to express his pleasure at what he had heard, and to thank Dr. Lodge for bringing such an interesting subject before the Institution in the admirable way he had done. At the same time Mr. Preece was sorry this was an old subject with him, but it was the first occasion he had listened to anybody else holding forth on it, and he was usually on the other side of the table when it came forward. In 1882—16 years ago—he had brought the subject before the British Association, and had never failed to lay before the yearly meeting the results of the experiments he had conducted.

Respecting Dr. Lodge's method, he felt something should be done to test his method on a practical scale, and had arranged for an interview the day following with Dr. Lodge, when he hoped that plans could be settled for such a test in a practical way.

Mr. Preece emphasised what was said in the paper, that his method at Lavernock has allowed messages to be sent daily for many months without a single failure, and the only difficulty, that of calling, has been surmounted.

It was announced that the discussion would be resumed on the 22nd inst., when Mr. Evershed's paper on "Telegraphy by Magnetic Induction" would also be taken. Yesterday Mr. Langdon was down for a paper on "Electrical Intercommunication in Railway Trains."

LEGAL.

National Telephone Company, Limited, v. Commissioners of Inland Revenue.

The case of the National Telephone Company, Limited (appellants), v. the Commissioners of Inland Revenue (respondents) came on Friday last before the Court of Appeal, composed of Lords Justices A. L Smith, Rigby, and Collins. This was an appeal by the National Telephone Company from a decision by a Divisional Court of Queen's Bench upon a case stated by the Commissioners of Inland Revenue under Section 13 of the Stamp Act, 1891.

Mr Asquith, Q.C., M P, and Mr. Roskill, were counsel for the appellant company, and the Solicitor-General (Sir Robert Finlay) and Mr. Danckwerts for the Crown.

In February, 1898, an instrument was presented on behalf of the National Telephone Company to the Commissioners of Inland Revenue under Section 12 of the Stamp Act, 1891, for the opinion of the Commissioners as to the stamp duty with which the instrument was chargeable. The instrument was headed: "The South of England Telephone Company, Limited," and ran as follows:—

"March 9th, 1896.—The undersigned hereby agrees with the South of England Telephone Company, Limited (subject to the above conditions), to pay them the sum of £12 per annum yearly in advance, the first payment to be made on the first day of the month succeeding that in which the wire and apparatus are fixed on the premises of the undersigned, and each subsequent payment to be made on the corresponding day in each and every following year, for the use of a private wire between No. 155, North Street, and the South of England Telephone Company's local exchange at Brighton. Either the company or the lessee may put an end to this agreement by giving to the other three calender months' notice in writing, expiring on the day previous to the rent being due in any year. No verbal notice can be recognised."

Then followed the signature of the renter and an addendum:—

"N.B.—All rentals are payable yearly in advance, and the first year's rent becomes due on the first day of the month succeeding that in which the wire and apparatus are fixed on the premises of the renter."

The National Telephone Company, Limited, had united the business of the South of England Telephone Company, Limited, with theirs, and for the purposes of the litigation, stood in the place of the latter company. The conditions and covenants entered into between the telephone company and the renter were not material to the issue. The Commissioners of Inland Revenue decided that the instrument was the only or principal or primary security for the sum of £12, payable annually for an indefinite period, that such a sum was neither interest for any principal sum secured by a duly stamped instrument, nor rent reserved by a lease or tack, and that the instrument was chargeable with Stamp Duty under the head, "Bond, covenant, or instrument of any kind whatsoever," in Schedule 1 of the Stamp Act, 1891, that is to say, a duty of 7s. 6d, being the *ad valorem* duty of 2s. 6d. for every £5, or fractional part of £5, on the £12 annually paid by the renter to the telephone company. The Divisional Court considered themselves bound by the judgment of a Divisional Court in the case of Jones *v.* The Commissioners of Ireland Revenue, and affirmed the decision of the Commissioners. The National Telephone Company, Limited, appealed.

At the conclusion of the arguments, which were of considerable length,

Their Lordships held that the instrument in question was a contract in writing whereby an obligation was undertaken to pay a sum of money at stated periods for an indefinite period, and so came within the clause of the Stamp Act, 1891, headed, "Bonds, covenants, or instruments of any kind whatsoever."

Accordingly the appeal was dismissed with costs.

Electric Construction Company *v.* Imperial Tramways Company, Limited.

In the Chancery Division on Friday, December 9th, Mr. Justice Stirling had before him a motion on behalf of the plaintiffs in this action. Mr. Butcher, Q.C., for the plaintiffs, said that the motion sought interim injunction to restrain the infringement of a patent, and the matter was one of some urgency, as the patent would expire in August next. He therefore hoped the Court would help him by expediting the trial.

Mr. Walters, for the defendant company, said there was no need to expedite. His clients were running tramways between Middlesbro', Stockton, and Thornaby, and they were not going to run away. They were willing to keep an account. He was instructed that other companies had been doing the same thing for years.

Mr. Butcher said that there was a clear case of infringement, and Mr. Walters replied that his instructions were that there was no infringement at all. Eventually it was arranged that the motion should stand over for a week, his Lordship remarking that he was disposed to say that this was a case in which it might be right to expedite the trial.

Savory *v.* Lloyd.

The opening of the action of Sir Joseph Savory against Messrs. Edward Lloyd & Sons, Limited, for alleged libel in regard to the City electric lighting which appeared in *London* was referred to last week. The hearing lasted for three days (7th, 8th, and 9th insts.), a great deal of evidence being given on both sides.

Mr. Carson, Q.C., made a strong speech for the defence, and the judge having summed up, the jury found a verdict for the defendants. Judgment was given accordingly, with costs.

BUSINESS NOTICES, &c.

Announcement.—The British Blahnik Arc Light Company, Limited, ask us to announce that Mr. E. H. Johnson left their service on the 1st inst.

Books Received.—"Marine Boilers: their Construction and Working, dealing more especially with Tubulous Boilers," by L. E. Bertin, translated by L. S. Robertson. Published by John Murray, London. 18s.

"Annuaire pour l'An, 1899." Paris: Gauthier-Villars.

Electrical Wares Exported.

Week Ending Dec. 13th, 1897	£	s.
Adelaide...	42	0
Amsterdam	120	0
Auckland	21	0
Bombay	236	0
Boulogne	11	0
Brisbane	184	0
Calcutta	14	0
Cape Town	1,096	0
Christiana	269	0
Constantinople	13	0
Durban	120	0
East London	150	0
Flushing	263	0
Gibraltar	2,812	0
Gothenburg	110	0
Hamburg	85	0
La Plata	11	0
Liban	50	0
Lisbon	25	0
Madras	30	0
Malaga	375	0
Melbourne	893	0
Naples	50	0
Novorossisk	64	0
Ostend	18	0
Port Elizabeth	50	0
„ Teleg. mat.	773	0
Stockholm	100	0
„ Teleg. mat.	375	0
Sydney	270	0
„ Teleg. mat. ...	333	0
Wellington	179	0
Yokohama	480	0
Total	£8,342	0

Week Ending Dec. 15th, 1898.	£	s.
Adelaide	44	0
Auckland	115	0
Bombay	10	0
Boulogne	88	0
Brisbane	12	0
Brussels. Teleg. mat.	200	0
Buenos Ayres. Teleg. mat.	512	0
Calcutta	62	0
Christiana. Teleg. mat.	494	0
Colombo	50	0
„ Teleg. mat. ...	1,397	0
„ „ cable ...	33	0
Durban	25	0
Gothenburg	33	0
„ Teleg. cable	308	0
Hamburg	265	0
Launceston. Elec. mtrs.	700	0
Liban	45	0
Madras	64	0
Melbourne	533	0
North Atlantic { Teleg. cable	4,500	0
Ostend	51	0
Otago	62	0
Penang	58	0
Port Elizabeth { Elec. cable	158	0
Reval	43	0
„ Teleg. mat. ...	312	0
Rosario. Teleg. mat. ...	616	0
Rotterdam. Teleg. mat.	388	0
Stockwell. Teleg. mat.	156	0
Sydney	291	0
Yokohama	120	0
Zanzibar	31	0
Total	£11,781	0

Foreign Goods Transhipped.

Flushing £39

Bankruptcy Proceedings.—Under the failure of Trehearne, Son & Crump, electrical engineers, 155, Fenchurch Street, E.C., the brankrupt, Arthur H. Crump, on Tuesday last, applied at the London Bankruptcy Court for an order of discharge. Mr. Pope, assistant receiver, reported that the firm failed in February, 1898, with joint liabilities, £1,151, and assets that had realised £289. That joint estate would, however, benefit by the separate estate of the bankrupt, Trehearne, which showed liabilities, £283, and assets that had already realised £1,148 6s. 2d. The partnership between Trehearne and Crump was entered into in May, 1897, when the latter paid £750 as capital to become a partner with Trehearne. A balance sheet was prepared showing the position of the business at that time to be a surplus of £750, and on the strength of that balance sheet, together with representations made by Trehearne as to the profitable nature of the business, and an indemnity by that gentleman against all debts subsequently found to be due and not entered in the balance sheet, Crump became a partner and paid in the £750 to equal his partner's interest. He subsequently found that the balance sheet was incorrect, and instead of there being any surplus there was a deficiency of over £800. He consequently stopped the trading last January, two private attempts to effect an arrangement with the creditors having proved abortive. The failure was attributed by Crump to the non-fulfilment by his partner of the indemnity and guarantee, but by Trehearne to his own betting losses, to bad debts, and to his heavy expenditure in public houses for the purpose of obtaining business. Trading with knowledge of insolvency was reported as an offence, but the registrar expressed the opinion that the bankrupt Crump was entitled to the sympathy of the Court and offered to grant a discharge subject to a judgment being entered for £5. The offer was accepted by the applicant.

The first meeting and public examination of Edward B. Pym, electrical engineer, Bar Chambers, Scarborough (residing at South Kensington), will take place on December 19th, at 12 noon, and January 20th, 1899, at 11 a.m. respectively, at Bankruptcy Buildings, Carey Street, W.C.

Catalogues, Lists, &c.—A neat and convenient sized catalogue of labour saving appliances has just been issued by Messrs. Graham, Morton & Co., Ltd., of Black Bull Street, Leeds. The book (of 265 pp.) contains descriptive accounts and illustrations of a large variety of machinery which will be found to effect a saving in the cost of handling material. The firm have made this branch of practical engineering work a special study, and they have workshops equipped with the most modern tools and massive hydraulic stamping, forging and flanging machinery. The catalogue is divided off into a number of sections, these giving details of elevator conveyors and colliery plant, carbonising plant, mill gearing, shafts, pulleys, and a great deal of sundry machinery and apparatus.

The Chloride Electrical Storage Syndicate send us copies of two sections of their new catalogue. Section A is devoted to lighting batteries, R type cells in glass and wood boxes being particularised and priced. Tables are given of particulars of batteries of cells, with accessories for incandescent lighting, weights of battery sets. Various battery sundries such as acid pumps, hydrometers, inspection lamp, wood stands, are also included. Section C gives prices and particulars in similar form of yacht and launch lighting and power cells. Illustrations are given of electric gigs or yacht tenders, hunting and fishing boats, and there are some remarks on the advantages of electric launches. Both of these lists are excellently printed and arranged.

Mr. Leslie Miller, of Hatton Garden, sends us a list of his patent electric lamp kettle, for which an attachment is made to the electric light wires in any room by inserting a wall-plug in its socket, or by temporarily using a lamp socket plug instead of the lamp.

Messrs. Smith, Simpson & Co., Ltd., of Manchester, have issued a list of Simpson's patent mining exploders for blasting operations. This exploder is very strongly and substantially built; all parts are machined, bored, or turned to exact gauge, every part being interchangeable. The armature is wound with best high conductivity copper wire, silk covered, also the armature bearings are large and will last years without showing sign of wear. It is claimed that the magneto exploders will not lose their power, even after years of use.

The Cambridge Assessment.—At the adjourned borough Quarter Sessions, held at Cambridge recently, judgment was delivered in the appeal case, the Cambridge Electric Supply Company, Limited, appellants *v.* the Overseers of St. Clement's Parish, defendants. The Deputy Recorder said he had been deputed by the Recorder to deliver his judgment in this case, which he had forwarded to him in writing. The learned Recorder said: "I have carefully considered all the evidence in this case, the arguments of the counsel, and the authorities cited, and I give judgment for the respondents, and dismiss the appeal with costs. The parties have agreed that the costs be taxed out of Court. Judgment will be accordingly."

Changes of Address.—The Horsfall Furnace Syndicate, Limited, has established a London office at 36, Great George Street, Westminster, in charge of Mr. Somerset Butler, where they will deal with inquiries for their well-known specialities, viz, refuse destructors and forced draught boiler furnaces. The firm is at present engaged upon a number of important contracts, among which are refuse destructors for the following:—The Corporations of Ashton-under-Lyne, Huddersfield, Ramsgate, West Hartlepool, St. Helier's (Jersey); the County Council of Lanarkshire; Vestry of St. Luke's (London); the Pembroke Commissioners (Dublin); Vestry of Fulham; Strand Board of Works; County Council of Cheshire; Metropolitan Asylum Board; H.M. Government; the Irish Board of Works. Most of the above include complete steam raising plant for use in connection with public electric light and power stations.

Mr. W. M. Mordey, consulting electrical engineer, has removed from 66, Victoria Street, to 82, Victoria Street (Grosvenor Mansions), Westminster, S.W.

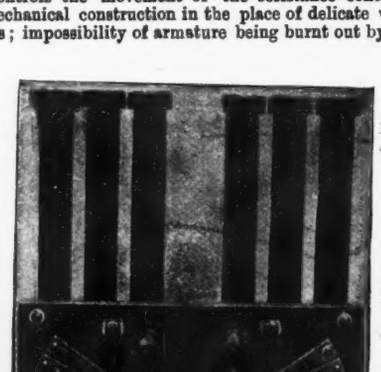
Dissolution of Partnerships.—Messrs. James and George Battcock Fuller, carrying on business as H. Fuller & Sons, electrical, gas, and hot water engineers, Crown Street and Upper North Street, Brighton, have dissolved partnership; Mr. G. B. Fuller will carry on the business.

Messrs. G. M. Callender and H. Greville Montgomery (Callender and Montgomery, agents for bitumen materials and damp resistance solution, 10, Victoria Street, S.W.), have dissolved partnership. Debts, &c., will be attended to by G. M. Callender.

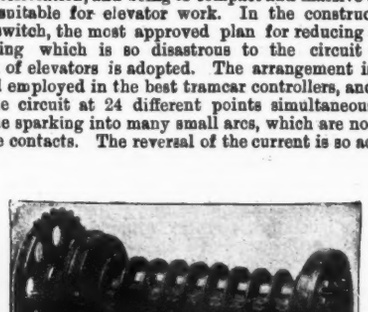
Electrical Engineering in France.—The engineering firm of Messrs. Daydé & Pillé, of Creil, France, has just been converted into a joint stock company with a capital of £120,000, and with the title La Compagnie Générale d'Electricité de Creil. The new company will control the Schuckert electrical patents in France.

Electrical Enterprise in Germany.—Writing still further on the subject of German electrical enterprise, the *Financial News* says there is no doubt that Germany has from the beginning played a principal part in the progress accomplished in the electrical industry, and defies, at present, any competition. With the assistance of their financiers and capitalists, German electricians have founded, not only within their own country, but also abroad, numerous and important enterprises. According to statistics just to hand Germany boasts now of 23 industrial or financial companies in connection with electricity, the capital of each of which amounts to at least 1,500,000 marks, the most important possessing a capital of 47,000,000 marks, whilst that of six others varies between 24,000,000 marks and 40,000,000 marks, five others range between 10,000,000 marks and 16,000,000 marks, and eight control from 3,000,000 marks to 8,000,000 marks. Amongst the last mentioned the Union of Berlin has just decided upon the increase of its capital from 3,000,000 marks to 18,000,000 marks. The share capital of these 23 concerns is 354,000,000 marks, out of which 317,000,000 marks has been paid up. But, with the debenture capital amounting to 102,160,000 marks, and the reserve funds of 36,564,714 marks, it can be stated that a total amount of 493,000,000 marks is invested in the great German electrical enterprises, not taking into consideration the numerous minor companies. The last dividend declared by 20 of these ventures has varied between 5 per cent. (minimum), and 15 per cent. (maximum), the average being 9 per cent. The following figures show the development of this branch of industry in Germany:—Of the 23 great companies, already mentioned, four were promoted from 1880 to 1890, seven from 1892 to 1894, four in 1895 and 1896, seven in 1897, and this year one with a capital of 1,600,000 marks. The extraordinary activity in 1897 is particularly remarkable with regard to the number of new companies as well as with regard to the capital, viz, 103,000,000 marks. Such a rapid development of the electrical industry naturally created great competition, which has brought about speculation to such a serious extent that German economists fear a crisis and a subsequent reaction upon the economic life of the country.

Lift Controller and Reversing Switch.—The General Electric Company are putting on the market an efficient lift controller and reversing switch with magnet control, which we illustrate below. The special advantages claimed for the apparatus are:—Perfectly accelerated start, free from jar or jerk; inability of resistance to be cut-out of circuit; impossibility of the elevator being forced to start under an overload, and blowing a fuse from this cause; no oil or air dash-pots are required to act as governors, as the elevator controls the movement of the resistance contacts; substantial mechanical construction in the place of delicate wiring and connections; impossibility of armature being burnt out by overload.



The resistance used with this controller is of tubular radiator type, with enclosed coils, capable of withstanding very severe service, without deterioration, and being of compact and massive construction it is very suitable for elevator work. In the construction of this reversing switch, the most approved plan for reducing the destructive sparking which is so disastrous to the circuit controlling mechanism of elevators is adopted. The arrangement is similar to the method employed in the best tramcar controllers, and consists of opening the circuit at 24 different points simultaneously, thereby dividing the sparking into many small arcs, which are not capable of burning the contacts. The reversal of the current is so accomplished



by a half turn of the sprocket wheel, which, by means of a chain connection, is readily adapted to any form of elevator mechanism now on the market. The wearing parts of this switch are renewable, each current-breaking clip being readily detachable, and the wiring between switch, rheostat and motor, is particularly simple, but three wires being used to connect them. With this apparatus it is possible to change over any ordinary belt-driven elevator into a direct electric, it being only necessary to fit small sprockets on the winding drum and belt shifter shafts, and connect controller and switch to a reversible motor, to derive the full economy of a direct connected installation.

The Court of Common Council and the Charing Cross Company.—The petition of the Charing Cross and Strand Electricity Supply Company for powers to supply current in the City district was considered by the Court of Common Council yesterday afternoon. After discussion the position was referred to the Streets Committee. We refer to this matter in our "Notes" columns.

Liquidation Notices.—The Electrical Coal-Cutting Contract Corporation resolved at a meeting held at Newcastle-on-Tyne on November 28th to wind up voluntarily as the company could not, by reason of its liabilities, continue the business. Mr. W. T. Goolden, 2, St. Nicholas Buildings, Newcastle-on-Tyne, was appointed liquidator.

A meeting of Rose & Bird, Limited, will be held at 24, Stamford Street, Blackfriars, on January 10th at 12 o'clock, to hear from the liquidator an account of the winding up.

The liquidator of the Esson Motor, Limited, will lay an account of the winding up proceedings before shareholders on January 17th at 12 o'clock at 8, Old Jewry, E.C.

London County Council.—The Highways Committee at a meeting of the L.C.C. last week, submitted a fresh report on the subject of the excessive span of the overhead wires of the National Telephone Company in Islington. It was resolved to enter into a supplementary contract with the National Electric Free Wiring Company for the supply of a duplicate dynamo and fittings at a cost of £274 for the Southwark fire brigade station.

South African Electrical News.—From the December issue of the *British and South African Export Gazette* we gather the following:—The additions to the electric lighting installation of Durban will include 20 arc lamps, two generators capable of supplying 2,500 incandescent lamps and 20 transformers. An electric lighting installation is in contemplation for Uitenhage, the current to be generated by water-power. The Bloemfontein Town Council have decided to extend their contract with Messrs. Reunert & Lenz for the electric lighting of the borough, so as to provide for the whole town, the cost to be over £17,000, instead of £7,500. Electrically driven ventilating fans are part of the contemplated equipment of the new Marine Hotel, Durban. Tenders were called last month for an electric lighting installation for Newcastle, Natal. The Johannesburg Town Council have accepted the tender, amounting to £11,100, of Messrs. Siemens, Limited, for the electric lighting of Old and New Doornfontein. The material is to be ordered in Europe. The supply of an electric lighting plant for the City Flour Mills, Capetown, has been entrusted to Messrs. George Findlay & Co, electrical engineers, Capetown. A complete electrical installation, with a 150 H.P. generator, has been fitted up at the Dunraven gold mine, Rhodesia.

ELECTRIC LIGHTING NOTES.

Bangor.—The town clerk has been instructed to apply to the Local Government Board for their sanction to a loan for electric light works.

Barnstaple.—The Corporation have decided to apply for a provisional order for the electric lighting of the town. They will therefore oppose the private application of which notice has been given.

Basingstoke.—The town clerk recently wrote to the Board of Trade asking if the Council could obtain an electric lighting license. The Board replied that licenses were granted for the purpose of experiment, but in view of the advance in electrical science the time had come when the longer tenure which can be given by provisional order alone may be generally adopted, under conditions receiving Parliamentary and not merely Departmental sanction, and in these circumstances the Board prefer that applications for statutory powers, especially in the case of local authorities should be made by means of provisional order rather than by means of license. The Council briefly discussed the matter last week. It was recognised that it is too late to apply for an order this year, but in the meantime the Council may consider the best course to pursue.

Beckenham.—The South Hill Park inhabitants have asked for the District Council's consent to the provision of a temporary supply of electricity from the Bromley (Kent) Electric Supply Company, Limited. The Council has the option either of taking a supply in bulk from the Bromley company and distributing it themselves, or allowing the company to treat South Hill Park as within the limit of their order, dealing with consumers direct. The clerk and surveyor are to prepare a draft agreement for the supply by the company of current in bulk.

Bedworth.—A meeting of the Parish Council last week considered the question of electric lighting. It was suggested that gas had had its day at Bedworth. A motion was agreed to authorising the Council to obtain professional advice, a charge to be made on the rates for the purpose. The assistance of the Warwickshire County Council and the Foleshill District Council is to be sought.

Birkenhead.—On 8th inst. a Local Government Board inquiry was held into an application by the Town Council for power to borrow £15,000 for electric lighting extensions. The town clerk and Mr. Bates, the electrical engineer, gave evidence.

Blairgowrie.—Mr. R. Frederick Yorke, M.I.E.E., visited Blairgowrie last week and examined various sources of power with a view to the introduction of electric lighting. Mr. Yorke was very favourably impressed by the means available for the objects in view, and expressed himself as thoroughly convinced of the practicable nature of the scheme. A syndicate is now being formed with a capital of between £8,000 and £10,000.

Bournemouth.—The Corporation has formally resolved not to give its consent to the Christchurch, Pokesdown and District Electric Lighting Order, 1899, promoted by the Bournemouth and Poole Electricity Supply Company, Limited. The proposed order provides for the transfer of the Bournemouth Electric Supply (Brush) Order, 1890, and the Poole and Branksome Electric Lighting Order, 1897, to the Bournemouth and Poole Electricity Supply Company, Limited.

Bromley.—The directors of the Bromley Electric Light and Power Company, Limited, in their first annual report, state that applications have already been received for upwards of 3,000 8-C.P. lamps, and it is anticipated that a similar amount will be required by the Chislehurst Electric Light Company.

Bristol.—A considerable part of the arc lighting extension in Bristol streets has now been completed by the Civic Electrical Committee.

Buxton.—The Electric Lighting Committee recently recommended that tenders should be invited for building the new electric light generating station.

Camborne.—On account of the expense the Urban Council will not at present apply for a provisional order.

Canterbury.—At the last Town Council meeting a long discussion took place with regard to the Electric Lighting Committee's recommendation that an additional sum of £12,000 should be borrowed for further work in connection with the lighting installation, and particularly for public lighting. Several members spoke strongly against the action of the Committee in allowing a larger sum to be spent than was actually borrowed. The recommendation of the Committee was carried. The consulting engineer, Mr. Robt. Hammond, attended before the Council, and gave details of the progress of the work. He pointed out that at the present time there were two sets of plant capable of producing 2,500 lights, all burning at once. There were accumulators which would also produce 2,500, and they proposed to add to this a 5,000-light set. Mr. Hammond also reported that he had ordered a further 50 meters from Messrs. Ferranti at £5 5s. each. He had arranged with the cable contractors to fix the meters in consumers' premises at 2s. 6d. per meter.

Chelsea.—The Vicar of Christ Church, Chelsea, the Rev. J. Pullein Thompson, acted as spokesman of a deputation to the Vestry last week to claim protection against the Chelsea Electricity Supply Company. The deputation brought against the company several causes of complaint—vibration, smoke, &c. After hearing the reverend gentleman at length, it was decided, on the proposition of Mr. Irons, seconded by Mr. Brass, "That the surveyor and medical officer be asked to report on the whole question of the present methods adopted by the Electricity Supply Company, particularly with regard to the effect on adjacent property and the nuisance of vibration, smoke, noise, &c., complained of, and that technical assistance be obtained."

Chelsea Vestry have declined the offer of the local electricity supply company to supply electricity for public lighting at cost price. A report of the surveyor showed that the cost would be much greater than that of the present system of lighting by gas.

Cheltenham.—At a recent Council meeting the minutes of the Lighting Committee showed that the electrical engineer had reported that the steam trials of the new 220-kilowatt steam alternator had been satisfactory; that he had received tenders from Messrs. Siemens Bros. & Co., Limited, and from Messrs. Nalder Bros. and Thompson for the accumulator and exciter switchboard, at £420 and £290 respectively; and that he recommended acceptance of the latter tender. He also recommended that the price of electric energy supplied to churches, chapels, and institutions of a like character be 4d. per unit, with a discount of 5 per cent. for cash, and that he should issue a specification for the supply of small coal under a six months' contract. The report was approved, and the tenders for coal ordered to be advertised for. The chairman of the committee reported that the electrical engineer had designed some special joint boxes for cables, and that he had permitted free use of these designs by Messrs. Callender, upon condition that a special discount should be given to the Cheltenham Corporation, and that the value of this discount upon the present order for boxes would be about £70. The minutes were approved by the Council, the Mayor taking the opportunity of referring in laudatory terms to the qualifications of Mr. Kilgour.

Chiswick.—The Chiswick District Council and the Chiswick and Aberystwith Electric Lighting Company have come to terms as to the agreement under which the latter shall light the district of the Council. The terms require that the area leased to the company shall be 7,500 feet, at a rent of £100 per annum, that the company may not erect a dust destructor, and that they shall re-instate all roads broken open by them.

Doncaster.—The architect for the new workhouse now erecting has asked several eminent electrical firms to tender for the electric lighting of the buildings.

Dublin.—The old gas lamps are being re-erected in Grafton Street and Westmoreland Street. They will be used until the new electric light cables are laid.

On 9th inst. at the meeting of the Municipal Council, Mr. Jones moved the estimate of the expenditure of the Electric Lighting Committee, £9,449 10s. 7d., and the estimate or the income, £9,781 5s. 11d. He thought that was very satisfactory. He was sure it would come upon some of the citizens as a very startling fact that this Committee had no occasion to ask the Council to provide in the estimates for any expenditure in connection with electric lighting during the coming year, because they had provided a credit balance to draw upon. All the talk and argument about the incapacity of the Corporation to manage their own affairs, and particularly the electric lighting, faded away before the incontrovertible figures presented to them in the estimates. They had paid sinking fund and interest, and had £1,500 to their credit at this moment. Mr. Ireland seconded the resolution, and remarked that the price of electric lighting was very high at present. The resolution was carried.

Ealing.—The Electric Light Committee has received applications for 92 8-C.P. lamps, making the total applied for 21,048, of which 19,970 have been connected.

Eccles.—The Board of Guardians have recently inquired the Council's terms for supplying current for the new Workhouse premises.

Falkirk.—On 9th inst. the formal ceremony of turning on the electric light, which has been provided by the Falkirk Central Electric Lighting Association for the purpose of illuminating the shops of its members, all of whose premises are situated in High Street, was performed by Provost Weir at the generating station in Blue Bell Close. The dynamo is driven by a 15-H.P. Tangye gas engine, and the current is distributed to the various shops by overhead cables run along the back courts of the High Street. The capacity gives light to 150 16-C.P. lamps. It is anticipated that the association will, in the course of time, put in a storage battery to maintain the light during the day, or in the case of any temporary stoppage of the machinery. The plant has been laid down by Messrs. Thomas Laurie & Co., Falkirk.

Glasgow.—At the Electricity Committee meeting last week a report on the proposed new electricity works at Coplawhill was submitted by Mr. Chamen, the electricity engineer, and Mr. Myles, the architect. The total cost for building and plant is estimated at £59,000, of which £16,000 has already been authorised by the Corporation for the new generating station. The report says that the works will of necessity take a considerable time to complete—say, two or three years—and judging from the experience connected with the station at Port Dundas, even longer. It is not thought, in view of the enormous and rapidly growing demand for electric supply, that any risk can be run of being further hampered, as they have been up till now, for want of the necessary buildings. Although the completion of the whole buildings might take from two to three years, sufficient progress might be made to allow of the first part of the plant being erected, though perhaps under temporary cover, within a period of nine months from the date of acceptance of tenders.

Grays.—The consultant's report on electric lighting is in the hands of the members of the District Council and will be shortly discussed The London School Board has asked the Council to consent to their laying lines from the Tilbury Docks to supply the *Shaftesbury* with electric light. The Council has agreed, provided the Board takes current from the Council's installation when it is ready.

Greenwich.—At the last meeting of the Board of Works a letter from the County of London and Brush Electric Lighting Company asking the Board's consent to the grant of an order conferring power to supply electricity in the parishes of St. Paul and St. Nicholas, Deptford, was referred to the Committees of those parishes.

Hackney.—The Board of Guardians has appointed a committee to consider whether, by utilisation of the present engine power, it would be an economy and otherwise advantageous to produce electricity for illumination and other practical uses in the whole or part of the Union premises at Homerton.

Hastings.—The Local Government Board have sanctioned the municipal purchase of the Hastings Electric Light Company for a sum of £58,000, repayable by equal instalments in 21 years. If the money is borrowed at 3 per cent., the annual instalments would amount to £3,862 11s. 3d.; but if the sum can be obtained at 2¾ per cent., the annual amount to be paid would be £3,672 10s. 6d. The *Hastings Times* says that no more Corporation stock can be issued until the New Powers Bill goes through Parliament. An arrangement has been made with Lloyd's Bank to let the Corporation have money as required at 3 per cent. The supporters of the Electric Light Committee are confident that this year's business will show a profit of 10 per cent.

Havant.—A Portsmouth paper says that there is a movement among influential men in the locality for the introduction of electric lighting.

Hereford.—The Sewers and Outfall Works Committee report that the electric light installation has been completed at the works, and is working very satisfactorily.

Heywood.—A sub-committee has been appointed to deal with the electric lighting question. A Town Council meeting was held last week to consider whether to apply for a provisional order.

Hinckley.—The District Council proposes to join hands with other local authorities who may decide to oppose the scheme of the Leicestershire and Warwickshire Electricity Supply Company.

Horsham.—Last Friday the Urban Council affixed their seal to the memorial to the Board of Trade for a provisional order.

Islington.—The Vestry has instructed the Electric Lighting Committee to report the cost of providing the electric light from Highbury Corner, along Canonbury Road and the New North Road, in order that the Islington installation may meet the electric lighting system being at present carried out by the Vestry of Shoreditch as far as the boundary of that parish.

Kingston.—The Corporation has agreed to supply current for the workhouse premises at a reduced rate, but the Guardians have now decided to invite tenders for a separate installation, the Corporation offer standing over for the present.

Lambeth.—Some months ago the South London Electric Supply Corporation, to which was transferred the provisional order granted to the Lambeth Vestry, approached the latter with a view to some of the principal streets being lighted by electricity. The fact may here be recalled that, by clause 20 of the transfer deed, the company undertook to supply electrical energy, free of charge, for 25 arc lamps to be erected by the Vestry, and to maintain and keep them in repair. In a letter addressed to the Lighting Committee in September, Mr. S. H. Webster, secretary to the company, states that the company is of course prepared to carry out the undertaking contained in the clause referred to, but that in the event of the Vestry desiring to save £750 to £800 on the purchase of arc lamp standards and lamps, the company would provide those lamps at its own cost, together with a further number of 225 lamps. The company further stated in the course of the communication that the agreement with the Vestry does not assume that current for lamps of unusual lighting power is to be supplied, and that a very fair amount would be 500 watts per lamp. The company is, however, prepared in the event of this project receiving the Vestry's approval, to supply no less than 625 watts to each of the 25 free lamps. Should electricity be supplied only to the free lamps at the various positions indicated by the Vestry, it is obvious that the company's ordinary alternating current must be used, as separate mains could not be laid to serve so few lamps, and although fairly satisfactory results could be obtained, much better could be produced by rectified or direct current. The current, however, for the 250 lamps embraced in this scheme will not be alternating; it will be rectified, and put on to mains laid specially to serve the public arc lamps. There will be five circuits, each circuit containing 50 lamps, all of which will give as perfect a light as is at present known in the way of electric lighting. It is only on the assumption that this proposal will be accepted at an early date that the Corporation can at this stage so husband its capital expenditure as to be able to supply and maintain the 225 arc lamps of 12½ amperes for £22 10s. per lamp per annum, each arc to be switched off at midnight and replaced by two 32-C.P. lamps until dawn. This price is quoted on condition that a contract is entered into until such time as the provisional order reverts to the Vestry. A detailed explanation of the company's proposals was placed before the Lighting Committee by Mr. Ellis, the chairman, and Mr. Manville, the engineer, on September 21st, when the question was adjourned until October 5th. On that occasion Mr. H. J. Smith, the vestry clerk, pointed out that it would be useless to expect the Vestry to assent to the propositions of the corporation, as they would, if accepted, entail a yearly payment of £5,062 for the 13 roads suggested by the company, as against £1,800, the present price of the gas lamps to be displaced, and would oblige the Vestry to continue the payment for the whole term of the order, and this before the Vestry had seen the new lighting in operation, or had been able to judge of its effect, and whether it was or was not worth the largely increased cost. The vestry clerk suggested that the corporation should be asked to give the Vestry a trial of the lighting of 25 lamps for a year, the Vestry to be free at the end of the year to continue the new lamps or to terminate the arrangement. The Lighting Committee approved of the vestry clerk's suggestion which was placed before the company, when Mr. Manville explained that it would be necessary to have at least 50 lamps on a circuit on the rectified system. The committee agreed to this, provided that the 25 lamps to be paid for should be at the rate of £20 per lamp per annum and the experiment continued for one year. In reply, the company expressed its inability to reduce the price, but consented to instal the 25 additional lamps on certain conditions. It appears that the present cost of gas in the streets proposed to be lighted by the company with 50 arc lamps amounts to £561, and that the 25 arc lamps to be charged for out of the 50 to be erected would be £562. The Lighting Committee, at a meeting of the Vestry on the 8th inst., recommended the adoption of the company's offer, on condition that the lighting of the arc lamps should cease at 1 a.m., and not at midnight. A long discussion took place, but eventually an amendment was carried by 42 to 11 votes adopting the before-mentioned suggestion of the vestry clerk and adhering to the terms of the contract for at least one year, and instructing the Lighting Committee to report as to the cost of the standards and the cost of lighting by meter as compared with the price asked by the South London or any other electric supply company.

Leamington.—The Electric Light Committee is writing to the solicitors of the Midland Electric Light Company, which at present supplies Leamington with light, asking, in view of the application of the Town Council to the Board of Trade for powers to light the town with electricity, whether the company is taking up the same position as last year, or if they are prepared to open up negotiations with a view to arriving at a settlement. If no settlement is arrived at, the committee will recommend that the application of the Council be by way of open arbitration with the Board of Trade.

Leatherhead.—The Urban Council had a brief discussion last week *re* its electric lighting provisional order, and in the end it was left with the clerk to obtain information from the firm of electrical engineers previously consulted.

Lincoln.—The Electric Lighting Committee recently approved Mr. Vesey Brown's details of the estimate of £19,000 for extra plant, cables, &c. It was resolved that Mr. Brown be empowered to arrange with Callender's Cable Company for an extension of the contract for the provision of the cables for a period of 12 months from the time fixed by the present contract. Addressing the Council last week, Councillor Harrison, chairman of the committee, said they hoped the current would be turned on in the course of a week or two. The engineering works of the country were exceedingly full of work, and it was a matter of great difficulty to obtain a quick execution of orders. This had caused the delay. No reply had yet been received from the Local Government Board respecting the proposed loan of £19,000 for works of extension. Already there were applications for 3,681 8-C.P. lamps, while the maximum supply with the present machinery was about 5,000. The new capital would go much further than the £22,000 already spent, for while they had now 4⅛ miles of cable, the extra capital would increase the mileage to 14⅛ miles. The minutes were adopted.

Llanrwst.—Mr. G. R. Peers, Colwyn Bay, has made arrangements to put down electric works in the town, but before going to any expense he is trying to get an undertaking from the Council that when the scheme was in full working order they would not secure a provisional order and work in opposition, and that they would not allow the gas company or any other outsider to secure that power. It is proposed to bring the whole subject up for discussion in Council.

London.—The St. Olave's Board of Works offers no objection to the application of the County of London and Brush Provincial Company as to system of supply.

Lourenco Marques.—Lourenco Marques, the Portuguese town on the verge of Delagoa Bay, has now got its electric lighting works. The undertaking has been carried out by a French syndicate, who purchased the original concession from a German resident, and formed a company with a capital of 850,000 francs. The whole plant is of French manufacture, even the bricks being imported. About 12 miles of streets require lighting, and though a portion of the suburbs is included in the scheme, additional plant will have to be laid down to supply the growing needs in this direction. The opening ceremony was performed by His Excellency Governor Machado.

Malvern.—The Board of Trade having drawn the Council's attention to the fact that its 1890 provisional order had not been put into force, that body has decided to ask for an extension of time.

Merthyr.—At last week's District Council meeting instructions were given to the clerk to send to the British Electric Traction Company the conditions upon which the Council had so far agreed to support their provisional order for electric lighting, and to ask that the company should send down during this week a responsible official to confer with them upon further points to be discussed.

Montrose.—In reply to the inquiry put by a member of the Police Commission as to what was being done in electric lighting, Provost Mitchell said he was very much misinformed if they did not have it in full swing before next winter began. The provisional order had been obtained, and all that was necessary now was the formation of a local company to carry out the provisions in that order. The clerk had received a letter from the Messrs. Edmundsons explaining the reasons for the delay.

Natal.—The inauguration of the electric lighting of the streets of Pietermaritzburg, the capital of Natal, took place just before the last mail left. Sixteen arc lamps were lighted, and others are to be switched on as convenient. Three alternators have been put down, but as the switchboard and other portions of the plant had not arrived it was only possible to work two of them. So far, one has supplied the private lighting of the city, and the other was running very light with the 16 arc lamps. The total capacity of the plant is equal to 6,000 8-C.P. lamps.

Northallerton.—The terms put forward by the Northallerton Electric Light Company for supplying electric light to the district by means of overhead wires, includes the free provision of two 1,000-C.P. lamps in the Market Place. The various matters in connection with the agreement will be discussed at the next Council meeting.

Oldham.—At last week's Council meeting Councillor Johnson referred to the proposed extension of the electric light station and the decision to write Prof. Kennedy at an early date to give advice on the subject. He asked if it had been definitely decided to extend the station, and whether the proposed extension was on account of the ordinary consumption of electricity, or with the view of using electricity for tramways. It was within the knowledge of the Committee that 12 months ago they had Prof. Kennedy down, and after going over the district he gave certain information. Unless, continued Councillor Johnson, the Committee had come to a definite decision to go on with the work, he could not see why they should invite Prof. Kennedy down again to confer with them, as he did not know what further information they would get than was obtained 12 months ago. Alderman Harrop, chairman of the Electric Light Committee, said there had been practically nothing done, but it was their duty to make arrangements for the future. The Committee were of opinion that Prof. Kennedy should come down, in order that they might inquire as to the adoption of the best means regarding the tramways. Only last week Manchester had to issue an appeal to use only a portion of their lamps. They did not want to be in the same position, and they were taking the proper means not to get into the unfortunate position the Manchester Corporation occupied at the present time. The minutes were adopted.

Radcliffe (Manchester).—The District Council have decided to make application to the Local Government Board for powers to borrow £16,000 for electric lighting.

Retford.—The Town Council has affixed the Corporate seal to a memorial for a provisional order for the borough of East Retford.

Richmond (Yorks).—The Town Council last week decided to get advice with a view to installing the electric light.

Rochdale.—A Local Government Board inquiry was held on 6th inst. with respect to an application on the part of the Rochdale Corporation to borrow £30,000 for electric lighting purposes. In the course of his evidence Mr Lacey, consulting engineer, said that electricity would be also supplied for traction purposes. The town clerk stated that the tramways, when the lease had expired, would be taken over by the Rochdale Corporation. Mr. Ball said that the buildings for electric lighting would cost about £9,500; the engine, &c., £4,700; and he also gave the cost of the other work.

Salford.—On the recommendation of the Electric Light Committee the Town Council have resolved to appoint a consulting engineer to advise them in connection with electric lighting extension works. Alderman Sir R. Mottram in addressing the Council last week said that when they were spending £200,000 they should obtain the best expert advice.

Sheringham.—At a recent parish meeting the Lighting Act was adopted. The surveyor reported on gas and electricity. A water-power electrical scheme is estimated at £4,600.

Shirebrook.—The Shirebrook Colliery Company is asking the Blackwell Rural Council for permission to take electric mains into Shirebrook for the supply of private consumers. The question of public lighting is also raised. The company is already supplying the hotel and shops on its own property. A committee is considering the matter.

Shrewsbury.—On Monday the town clerk intimated to the Council that he had received a letter from the Local Government Board authorising the Council to borrow £30,463 for the purchase of the undertaking of the Shropshire Electric Light and Power Company and the extension of the works.

Sleaford.—Last week the Council discussed the advisability of obtaining a provisional order for the installation of electric light in Sleaford, and it was ultimately resolved to take the advice of a consulting engineer.

Sowerby Bridge.—The District Council has decided to apply to the Local Government Board for a provisional order for generating and distributing electricity for illuminating and motive power purposes throughout the Council's Gas Act area.

Stockton.—Last week the Corporation ordered that application be made to the Public Works Loan Commissioners for a loan of £28,482 for purposes of electric lighting at 2¾ per cent. over 25 years.

A site for electricity works is to be purchased near the gasworks at a cost of £1,900.

Sutton Coldfield.—The Town Council last week passed the draft provisional order and application to the Board of Trade, and also resolved to oppose the scheme of the Leicestershire and Warwickshire Electric Supply Company, which would include Sutton Coldfield.

Tanfield (Durham).—The following is a list of tenders, quoted by the *Contract Journal*, submitted for the supply and erection of various electric plant throughout their district, including engines, dynamos, cables, insulators, poles, &c., to cover a distance of between one and two miles, for the Tanfield Urban District Council. Mr. Robert Heslop, Burnopfield, R.S.O., surveyor:—

No. 1.—Installation.

Corlett Electrical Company, Mosley Street, Newcastle-on-Tyne	£480	0	0
H. Armstrong, Chester-le-Street	618	11	9
W. Dalzell & Co., Quay Side, Newcastle	700	0	0
S. H. Gowdy, Cloth Market, Newcastle	1,080	0	0
Brush Electrical Company, Queen Victoria Street, London	1,471	0	0

No. 2.—Engine, Dynamo, &c.

Corlett Electrical Company	440	0	0
H. Armstrong	380	5	9
W. Dalzell & Co.	390	0	0
S. H. Gowdy	1,550	0	0
Brush Electrical Company	870	0	0

Toronto.—Toronto recently resolved to embark on a new and complete scheme of electric lighting, and tenders were invited from various persons and firms. Among the tenders is that of the Anglo-American Electric and Supply Company, which is represented locally by Mr. G. P. Magann, Dr. R. A. Pyne, M.L.A., and Messrs. G. S. Ransom and Henry M. East. The *Financial News* says that the company offers power in such quantities as may be required from time to time by the Corporation at cost, after paying a dividend of 10 per cent. to the shareholders upon a capitalised stock of $5,000,000. The cost to the general public, it is represented, would not exceed 1 cent per horse-power per hour, and it is suggested that even this figure may be considerably reduced. The company proposes to put in a 10,000 horse-power plant at a cost of about $1,000,000, exclusive of site and wiring. The company also proposes to carry on the manufacture of electric supplies on a large scale, and the capital stock is fixed at the foregoing figure to allow of this branch of operations. All the company's works would be located in the city of Toronto. No decision has yet been come to in the matter, we believe, and it remains to be seen whether the Anglo-American Company can compete on favourable terms with local enterprises.

Torquay.—At a recent Council meeting the electrical engineer reported to the same meeting that on March 17th, 1898, there were 48 consumers, the lamps connected being equivalent to 3,700 8-C.P. Consumers on December 5th numbered 95, the lamps connected being equivalent to 6,500 8-C.P. There were 14 applications in hand. The private installation at The Knoll has been replaced by a public supply. The number of units generated is as follows:—From March 17th to June 24th, 26,858; from June 25th to July 31st, 7,121; from August 1st to August 31st, 6,701; from September 1st to September 30th, 10,990; from October 1st to October 30th, 85,721; from October 31st to November 29th, 18,344; total output, 85,735. Revenue from March 17th to June 24th, £561 16s. 7d; June 25th to September 29th, £530 0s. 2d.; total, £1,091 16s. 9d.

The electric light plant at the refuse destructor was run for the first time last week. The destructor room is illuminated by three Jandus arc lamps, and there are some 20 incandescent lamps inside and outside the building. All the work, including the supply of the dynamo, &c., has been carried out by Messrs. Massingham & Mann.

A report on the capital expenditure of the Torquay municipal electricity undertaking was laid before the Council last week. Alderman Kerswill, the chairman of the Electric Lighting Committee, said the total outlay was £24,867, or £1,726 more than the original estimate; but after deducting £920, the value of material available for the extension of the mains, the actual cost was £23,946. The amount of the loan sanctioned and raised was £22,300, so that there is an actual deficit on capital account of £1,646. The detailed account showed that 20,050 yards of cable were laid at a cost of £5,589, an increase of £208 on the estimate; 52 arc lamps cost £1,346, less by £437 than the estimate which was for 70 arc lamps; boilers, engines, and machinery at the station cost £13,011, being £840 over the estimate. On the building account there was also an excess expenditure of £1,115. A letter from Mr. W. H. Trentham, the consulting engineer, was read in which he dealt with the various items of expenditure, and explained how the increase had arisen. In connection with the mains, the outlay would have been only £5,000, or £381 less than the estimate, but for the fact that as work proceeded the committee authorised the laying of extra mains, costing £589. The increase in the expenditure on the machinery account was due to the change which was made after the work began on the site appropriated for the installation. This also caused the increase in the cost of the alteration of the buildings, but the effect of the change was that the capacity of the works can be increased by two-thirds without further expenditure upon buildings. "I may also point out," added Mr. Trentham, "that the cost per kilowatt is only £53—a much lower figure than in any other public works in the kingdom, in some of which the capital outlay has been very extravagant." The Council decided to defer the discussion of the report until March next, when the financial year closes.

Tottenham.—The District Council last week resolved to apply for a provisional order for electrically lighting the district, this step being presumably taken to keep out companies.

Ulverston.—The Board of Trade has written to the District Council asking for observations respecting a proposal to allow the Windermere and District Order of 1895 to remain in force in Claife and Hawkshead, and to revoke for the remaining portion of the rural district. The Council has resolved to ask the Board to revoke the whole of the order.

Wales.—The British Electric Traction Company has informed the Vaynor and Penderyn Rural District Council that its electric light scheme, so far as it affects this district, will not be proceeded with.

West Bromwich.—As briefly intimated in the Electrical Review of last week, the West Bromwich Town Council have decided to oppose the provisional order being applied for by the Midland Electric Corporation for Power Distribution, Limited, for power to supply electricity in the borough of West Bromwich, amongst other places. At the meeting of the West Bromwich Town Council on Wednesday in last week, the Mayor (Councillor S. Pitt), referring to this application, said it would be remembered that the Council applied for a provisional order last year. They were then opposed by the company, but notwithstanding that, the Council obtained their order. The same company were now coming again, but they considered that electricity for both motive power and lighting purposes should be in the hands of the Corporation. He pointed out further that at a meeting of the Municipal Corporations Association held in London, it was resolved recently to organise a united opposition to companies entering towns and trying to take from Corporations powers which they had already obtained from Parliament. They, in West Bromwich, were members of the Association, and he had no doubt they would be assisted by that Association. The Mayor said that the Electric Lighting Committee were taking the quickest steps they could in the matter, consistent with safety. They were now awaiting expert advice, after which the committee would be able to report more fully to the Council. The resolution to oppose the provisional order was carried unanimously.

The Walsall Town Council has resolved to take the necessary steps for opposing the Bill of the British Electric Traction Company, Limited, for adopting electricity on the South Staffordshire trams.

Wigan.—Last week Alderman Holmes, in moving the minutes of the Electric Light Committee, said the committee had passed a resolution recommending the Council to put down an installation to supply the town with electric light. He hoped the Council would see its way to confirm the resolution. The minutes were confirmed.

Woking.—In connection with the proposed purchase of the undertaking of the Woking Electric Lighting Company, the District Council has decided to spend 30 guineas to obtain the opinion of an expert on the value of the works.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Blackpool.—Some time ago the Town Council decided to discard the conduit system of electric traction and go in for the overhead system. On Tuesday last week, however, the work of erecting the overhead poles was temporarily stopped by the newly elected Council until the General Purposes Committee had met. This meeting has now been held, when it was pointed out by the borough electrical engineer that on a fine day the minimum leakage of current under the present (conduit) system was 45 per cent. That was a very serious matter, as the Board of Trade only allowed a maximum of 2½ per cent. Then the new copper conductors cost £800 per year, repairs to collectors absorbed £400, while the cost price of the electricity which ran to waste in the earth, and from which they derived no benefit, was £700 per year. This, says the *Yorkshire Post*, caused a loss of £2,200 per year, and the overhead system would prevent that. It was decided to adopt the overhead system by 25 votes to 11. The cost of the change will be £6,000, and this sum, it is anticipated, will be saved within two years.

The General Electric Company recently informed the Lighting and Tramways Committee that an error of £200 was made in their estimate for trolley wires and insulators. The General Purposes Committee will meet to consider the matter.

Bristol.—Last week reference was made to a serious hitch which had occurred between the Bristol Sanitary Committee and the Tramway Company now engaged in turning the whole of their horse tramways into an electrical system. The difference had arisen owing to the committee calling on the company to erect central poles in certain wide streets to carry their trolley wires, while the company claimed that they had under their Acts received power to work on the span-wire system. An appeal to the law courts appeared at one time imminent to settle the respective powers of the two bodies. The tension has now been eased a little, owing to the company adopting a more conciliatory attitude. The city engineer communicated the decision of the committee to the company in a letter in which he said the committee were unable to approve of the positions proposed by the company for their posts in those streets where, in the opinion of the Corporation, the posts should be in the centre of the carriageway, or on the footway on one side only; the committee therefore hoped the company would submit fresh plans, showing the positions altered in accordance with the committee's suggestion. The city engineer continued:—"It is not the desire of the Corporation that the company should be obliged to do anything beyond their statutory powers, or impossible on technical grounds. I have authority, if I think fit, to approve of any suggestions of the company with regard to the position of particular poles on these grounds. The committee do not think that the company have any ground for complaint on account of its being necessary to shift the present positions of certain of the tramways which have only lately been relaid in a manner suitable for electric traction, as the result appears to be contemplated by the Electrical Powers Act, where it is provided that the company may, with the consent of the Corporation, deviate from the lines of the tramways as existing at the time of making the alterations. That consent the Corporation are ready to give. The company will recollect that when the tramways in question were relaid they did not consult the Corporation as to the positions of the posts. Had they done so, the Corporation would have had an opportunity of informing the company of their views on the matter." The secretary of the company, in his reply, expressed great disappointment at the city engineer's letter, and continued:—"The concluding remarks of your letter (those quoted above) indicate some misunderstanding, inasmuch as most of the lines in question were relaid before the authorisation of electrical traction, and now only require bonding; as a matter of fact, since the passing of our Acts of last Session, we have carefully abstained from proceeding with works which we thought might be affected by the works of your committee upon this head, and in doing so, as your practical knowledge will confirm, we have incurred great inconvenience and expense in transferring our large gangs of workmen from one part of the city to another, and restricting their operations to short lengths, which were regarded as not open to any question. Moreover, the directors are quite unable to follow your argument that, because their Act of Parliament prohibits any deviation from the existing lines of tramways, except with the consent of the Corporation, therefore we have no ground of complaint when called upon against our wish to reconstruct a second time extensive lengths of tramways in deviated positions, although for the purposes of electrical adaptation such a deviation is altogether unnecessary. However, in their desire to meet the views of the Committee the directors have given the matter further consideration, and now suggest that possibly the difficulty may be overcome if the Committee will revert to their resolutions of October 26th and November 2nd as an approximate basis, with the understanding that the company shall not be asked, as a general rule, to again reconstruct tramways already relaid, but that special places—such as the locality of St. Augustine Bridge—shall be specially considered. I would suggest that these details could be most conveniently settled at a conference between yourself and the company's officials, and you could then report to your Committee definitely the extent to which we are willing to go with a view to amicably arranging the whole subject." The resolutions suggested as "an approximate basis" required central poles in streets 40 feet wide and upwards (instead of 36 feet, as in a later resolution), and allowed the company to use the span-wire system with double poles in streets less than 40 feet wide, but provided that in streets less than 30 feet between the kerbs the company should use side poles with bracket arms, or span wires between the houses. The Sanitary Committee has authorised their engineer to confer with the tramway officials, as suggested by the company, but did not commit themselves to any change in their attitude.

Derby.—The Corporation Parliamentary Committee have issued a report, which was presented at the Council meeting on Wednesday, stating that, subject to the approval of the Council, they have agreed to purchase the tramways for £32,000. The committee recommended formal opposition to the Bills of the General Power Distributing Company, and of the Leicestershire and Warwickshire Electric Supply Company.

Dewsbury.—The British Electric Traction Company have given notice of their intention to apply for powers under the Light Railways Act to construct tramways from Dewsbury to the surrounding towns and villages. Dewsbury Corporation have decided to oppose the company, and plans have been prepared by the borough electrician (Mr. O. M. Jonas) for a local system of electric trams to serve Dewsbury, Heckmondwike, and Ravensthorpe. Much interest is being taken in the matter. Last week the Dewsbury Ratepayers' Association was held, several Town Councillors being present. Mr. Robert Armstrong, a vice-president of the Dewsbury Tradesmen's Association, read a paper dealing generally with the question of electric traction. He first showed what a great convenience to the whole district electric trams would be, and then said he had communicated with the British Electric Traction Company on the matter. In reply to his questions, the company's representative had stated that it would take from 12 to 18 months to get trams running after the date of the confirmation of the order; in some places the company would take electrical energy from corporations at 1d. or 1½d. per unit, with a sliding scale for large consumption; the consumption of energy would be about one unit per car mile. The company preferred not to give an option of purchase under 21 years; but if the Corporation would accept a clause by which they would pay a reasonable sum as compensation for compulsory sale, a purchase could be arranged at an early date. Mr. Armstrong went on to say that if a private company could make a system pay, the Corporation could do so, and then gave figures showing the progress of electric traction. A long discussion followed the reading of the paper, and although no resolution was passed, the majority present expressed themselves in favour of the Corporation taking the matter up in preference to allowing a private company to come in.

Electrical Cabs in France.—The Compagnie Générale des Petites Voitures called an extraordinary general meeting of its shareholders on Monday, 28th ult., for the purpose of getting them to authorise the conversion of the existing debenture bonds from 4 per cent. to 3½ per cent., and to make a fresh issue of 10,000,000 francs worth of 3½ per cent. bonds to enable the company to proceed with its scheme of electric motor traction. This was unanimously agreed to, and the whole of the fresh issue has already been taken up by the Crédit Lyonnais. The *Financial Times* makes some comments upon the matter. The Compagnie Générale des Petites Voitures is a very large and old-established concern, with a big capital, and for some time past its directors have come to the conclusion that a radical change must sooner or later take place in the present horse traction owing to the immense development which is now taking place in the means of transport in Paris. For the last three years the company has been experimenting at considerable cost with various kinds of motors, and it has at last fixed upon an electric motor which, after various trials, is considered to be the most practical for the purpose of cabs plying for public hire. In their report to the shareholders the directors do not undertake to say whether the application of mechanical traction on a large scale for the use of cabs will be a success, but they think that the time has now arrived when a fair experiment may safely be made. This experiment, to be of any practical use, must be conducted with a sufficiently large number of cabs to solve the question of cost price and to enable the establishment of a comparison between the expenses of animal and motor traction. The directors consider that 100 cabs at least are necessary for the experiment, and should the result prove satisfactory, their intention is to place upon the streets as many cabs as possible by the year 1900, in view of the great exhibition. The first depôt for the new automobile cabs have just been finished; a number of "cabbies" have been trained to engineer through the streets of Paris the new electric motor cabs, and ere long the 100 vehicles will be plying for public hire. Even as it is, there are a few to be seen about the streets, but these have been hired out to private persons. It will thus be seen, says our financial contemporary, that whilst in London the company formed to run electric cabs has not been very successful so far, in Paris, on the other hand, the matter is being taken up on a large scale by a powerful company only after three years of trials, and even now the directors do not guarantee that the experiment will be a success, since they say no industrial experience on a large scale of electric cabs has yet been made, and therefore it is impossible to say what the results may be. Notwithstanding this, however, the shareholders appear to have every belief in the wisdom of their directors and in the future of mechanical traction, and were quite content to vote a large debenture issue for the purpose.

(*Continued on page* 905.)

CITY AND SOUTH LONDON RAILWAY EXTENSIONS.

There has been quietly proceeding for some time past underground-operations in connection with the extension of the City and South London Railway that are full of interest. They are in some respects less remarkable than those connected with the more ambitious Central London and Waterloo and City lines, but, considering the short length of track, the incidents of construction are noteworthy. They include carrying the line under the bed of the River Thames, and constructing a station underneath one of the City churches. As the forerunner of underground electric railways, the City and South London will always merit the admiration of engineers, for it was on this line that the late Mr. Greathead completely demonstrated the utility and economy of the method of tunnelling so intimately associated with his name. Moreover, it ought not to be forgotten that the electrical portion of the system was under the care of the late Dr. John Hopkinson.

It will doubtless surprise many to know that 13 years have elapsed since the construction of the City and South London Railway first began. The constructive work has almost faded away from one's memory, and it may be of interest to recall some of the distinctive features of the original line. In October, 1886, the construction of the first of the two tunnels which it was decided to carry under the Thames was commenced. The second was started in the following year, and about the same time work was begun upon the site of the stations. Before the end of 1888 Messrs. Sir W. G. Armstrong, Mitchell & Co., commenced work on the hydraulic lifts and machinery which were to give access to the station, and in 1889 the contract for the electrical equipment was let to Messrs. Mather & Platt. The experimental running of the electric locomotives and two of the carriages was commenced in February, 1890, on the City section, and continued from time to time until the completion of the works. The inauguration by H.R.H. the Prince of Wales in November, 1890, was followed on December 18th by the opening to the public. In the first half-year 174,000 train miles were run, and 2,412,000 passengers were carried. In the year 1894, 458,000 train miles were run, and 6,900,000 passengers were carried.

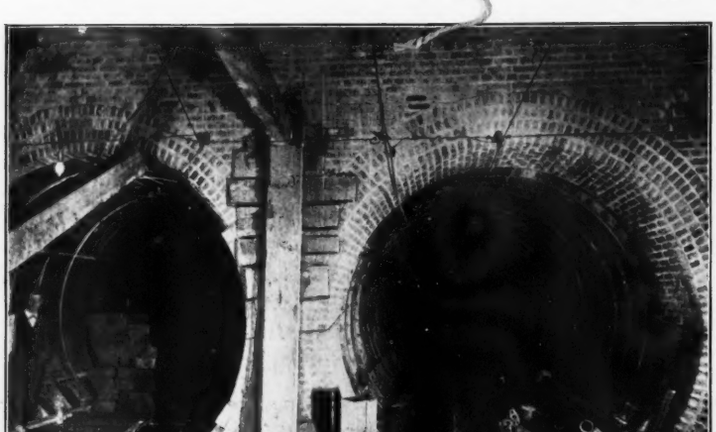
Junction of New and Old Line.—The original line is shown on the left.

The line is composed of two iron tunnels, which, besides passing under the Thames, in some places goes through water-bearing strata, the important feature of this portion of the work being the use of compressed air in combination with shields. Grouting by compressed air was first employed on this line for the purpose of filling in the cavity left by the advance of the shield.

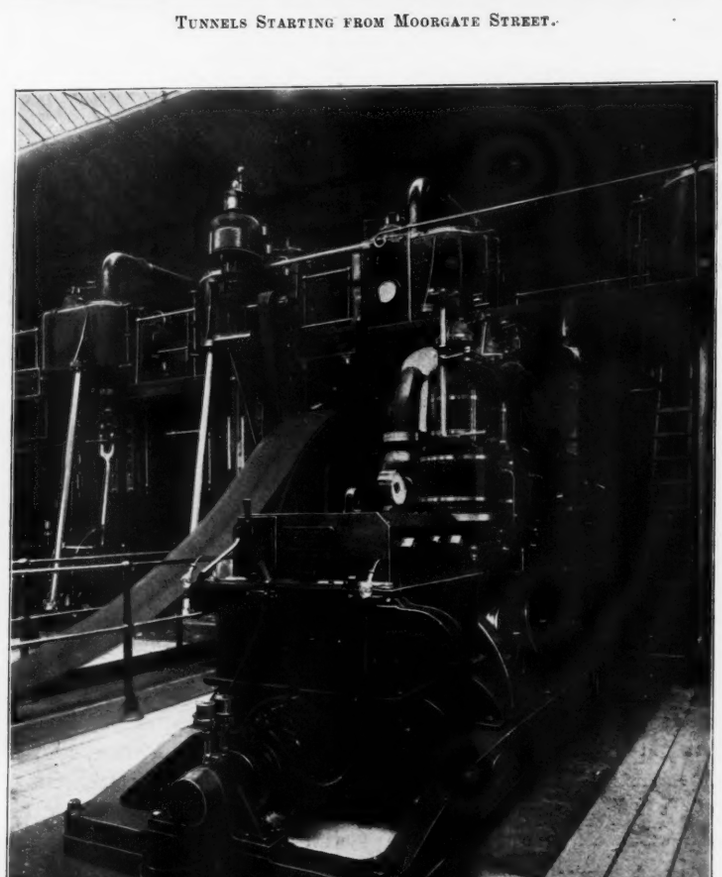
The generating station is at the Stockwell end of the line, and comprises rope-driven generators. An interesting feature is the Willans engine, which takes the fluctuating load of the system without any trouble. We have included two views of the interior of the generating station, one showing the whole of the electrical plant and the other illustrating the Willans-Siemens set.

Financially, the line has not been the conspicuous success

it deserved. The dividends have never been higher than 2 per cent., and some few years elapsed before this was achieved. In one of the latest statements made by the chairman of the company anent the cost of working the line, it was shown that the percentage of working expenses to receipts (first six months 1897) was 57·2. If the cost of working the lifts was deducted, the percentage came out at 50·40. The receipts per train mile were 2s. 4d., locomotive expenses were 6·06d., and the average number of people carried was 46·54.



Tunnels Starting from Moorgate Street.



Willans-Siemens Set.

In the extensions from London Bridge to Finsbury Pavement, which is part of a larger scheme that will eventually take the line to the Angel at Islington, the company look for returns that will materially increase the present dividends, and this anticipation is probably justified, for the line will directly connect Moorgate Street Station with London Bridge Station.

By building this new line the system will undoubtedly be able to deal satisfactorily with an increased traffic; moreover, the new tunnel under the Thames will obviate the difficulties arising from the small capacity of the King William Street station. On this point the chairman of the company declared some time ago that on account of the smallness of the station the line was not worked to more than a third of its capacity. The new line, therefore, is a distinct branch from the Borough station, this will enable the company to get a station close to the London Bridge terminus, and the platforms of the two railways will be connected together by means of an underground passage. At the Moorgate Street end, the line will eventually be in connection with the Great Northern and City Railway, so that in an interchange of traffic the South London line would gain material benefits. There will be also provided an underground connection with the Metropolitan system at Moorgate street. The new line will have a station at the corner of Lombard Street, and this will be in close connection with the Bank station of the Central London Railway and the Waterloo and City lines. It will be seen that when the line is complete, instead of being out of touch with other railway systems, as it has been previously, it will be connected with a complicated network of railways, and will, moreover, be in direct contact with the most thronged highways of the City. We were long ago of opinion that the City and South London Railway, with its termini at London Bridge and Stockwell, would never reach a highly prosperous state, but the additional section now under construction will, we think, enable the system to attain to a most flourishing condition.

The most conspicuous feature from an engineering point of view is the underpinning of St. Mary Woolnoth Church, immediately underneath which the main shaft for the lifts have been sunk. The company, by an Act of 1893, had power to pull the church down, but when, in 1896, an extension of time was sought, the condition was imposed that the church was to be left intact, but that the subsoil could be used and the station constructed beneath the church.

The large oblong shaft is 73 feet 6 inches by 24 feet, divided into five bays, in which will work electric lifts made by Messrs. Easton, Anderson and Goolden. It is lined with cast-iron casements for a depth of 52 feet from the top, the remaining 28 feet being brick-

work, in which are formed the entrances and exits to and from the lifts. The two station tunnels are 21 feet diameter, and lined as usual with cast-iron rings.

In underpinning the church the four main girders, designed to support the four groups of columns which carry the roof, were fixed in position, and small needle girders were then threaded through the bases of the columns. The south wall was pierced at intervals of about 5 feet, and strong needle girders fixed through the wall, one end resting on the solid stone on the outside, and the other tied down to one of the main girders supporting the columns. For the wall on the north side the same method could not be adopted, as the work could not be executed from the street. One main girder was therefore designed to carry the whole weight. Needle girders were fixed just below the church floor level, under cover of which the wall was cut away to allow of the girder being fixed. After the wall had been securely pinned up above the girder, suspended needles were put in one at a time, and the intervening masonry held up by cross steel joints placed on the top of the needles. Grouting under air pressure has been largely employed in the work, especially for filling up between the girders and the old masonry.

Tunnel Cutter driven by Electric Motor.

It is fitting that electricity should already play a conspicuous part in the construction of this line, and quite recently we had an opportunity of inspecting the temporary electrical plant, which, at the present time is supplying energy for lighting the workings, to the contractors' locomotives, and to a motor which drives a tunnel cutter.

At a point adjoining Moorgate Street Station a small generating plant has been erected on the surface. This consists of two 50-H.P. loco. type boilers, one Ransomes, Sims and Jefferies vertical compound engine of 60 B.H.P., running at 300 revolutions, coupled direct to a Siemens compound wound dynamo with an output of 150 amperes at 210 volts.

There is also a Browett-Lindley, Paterson & Cooper combination of almost similar size. These two sets are kept busy day and night. At the London Bridge shaft a very similar plant is at work, and together they supply power to four Siemens locomotives, three of 12 B.H.P., and one of 15, and, as we have already said, to a motor, and for lighting the whole of the workings.

These locomotives, on which are series-wound motors with double reduction gearing, have been built specially for this kind of work, and have proved most valuable. The function of these locomotives is to draw the excavated clay to the bottom of the shafts, where it is drawn up and carted away.

A journey on one of these vehicles brought us to the end of a tunnel in course of construction. At this face the motor-driven cutter was being operated. One of our illustrations shows the tool in the process of being dismantled. The motor is of the enclosed type, and, with the whole machine, was built by Messrs. Easton, Anderson and Goolden.

Current is transmitted to the locomotives by means of overhead wires, the collector being a form of swinging frame. The trolley wire is ·25 H drawn copper supported from the top of the tunnel by "Etna" or porcelain insulators, while a third method combining novelty, cheapness and efficiency consists of a hard wood block bolted to the iron of the tunnel, and attached to it a strip of strong raw hide, which is made fast to the wire by means of a piece of thin copper sheet. The result is considered very satisfactory, and owing to the flexibility there is less sparking at the points than with the more orthodox methods.

Contractors' Electric Locomotive on City and South London Extension.

One of the illustrations shows the junction of the new tunnels with the old ones. This is a most interesting piece of work, and, moreover, was accomplished without at any time stopping the traffic of the City and South London Railway.

The lamps are ordinary 200-volt B.C. type, and are provided with two short pieces of wire attached by a spot of solder direct to the terminals in the cap, they are by these suspended from the wires, which are bare copper of ·3 diameter. Although the voltage is 200, there has been no burning out owing to the use of this method.

Considering the temporary nature of the work the wiring both for the locomotives and the lighting is of a substantial character.

The contractors for the undertaking who employ this very considerable electrical plant are Messrs. John Mowlem & Co., of Westminster, and their electrical engineer who was responsible for the work is Mr. Herbert Allen.

NOTES ON THE RELATIVE COSTS OF COPPER AND ALUMINIUM.

By JOHN B. C. KERSHAW, F.I.C.

The rapid increase in the price of copper during the last few weeks, to which attention has been drawn in the "Notes" columns of the Electrical Review, has given additional interest to the question of the relative values of copper and aluminium when used for conducting purposes; and the writer therefore takes this opportunity to amplify the short article upon this subject published in the issue of the Electrical Review for September 2nd last, and to reply to some of the criticisms passed thereon.

The average price per ton of G.M.B.'s for August of this year was £51 15s., the price for the second half of November was £56 2s. 6d., the advance in price has therefore been £4 7s. 6d. per ton.

The relative values of rolled electrolytic copper in a form ready for drawing into wire at the two dates, may therefore be taken as £55 10s. and £59 17s. 6d. per ton. Inserting the latter price in the formula given in the article of September 2nd, namely,

$$\frac{S \times P \times c}{s \times p \times C} \text{ in which}$$

S = Sp. gr. of copper.

P = Cost price per pound of copper in bar form.

C = Conductivity of copper,

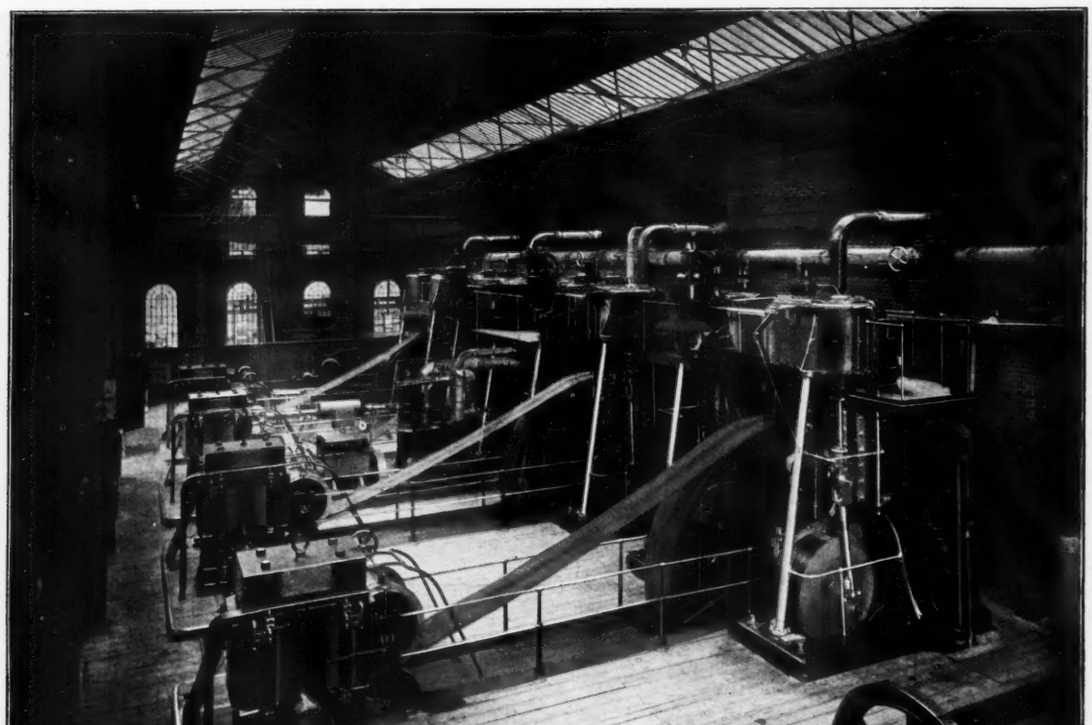
and s p c represent the corresponding values for aluminium, we have

$$\frac{\text{copper}}{\text{aluminium}} = \frac{8{\cdot}93 \times 6{\cdot}415 \times 59}{2{\cdot}68 \times 15{\cdot}85 \times 100} = \frac{100}{125}$$

Aluminium, therefore, in spite of the rise of over 8 per cent. in the price of copper, is still one-fourth more costly for bare conductors of equal length and equal resistance.

Mr. Zingler pointed out in a letter published in the Electrical Review of September 9th, that the Pittsburg Reduction Company are quoting aluminium in bar or rod form, suitable for conducting purposes, at 29 cents (14½d.) per lb. It was stated by the writer, however, in the preceding article on this subject, that this price is *below the actual cost of production*, and that it was only fixed for the purpose of inducing electricians to make trial of aluminium as a conductor. That the offer is successful in attaining its object, is proved by the fact that in U.S.A. an aluminium air line for a transmission scheme between Snoqualmie Falls and Seattle, Washington, a distance of 34 miles, is now in course of erection, and 150,000 lbs. aluminium will be used in its construction. The profits on such sales of aluminium are, in the writer's opinion, non-existent, and the price of 29 cents per lb. could not be maintained in the face of any extended demand for aluminium for conducting purposes, but would rise to, or even above, that used by the writer in his calculations—15 85d. per lb.

The objection taken by Mr. Steven in the letter published in the issue of September 16th, to the use of values for the two metals in bar form, as basis of these comparisons, would have had more weight, if the substituted values were for the metals in the form in which they would be used for carrying heavy currents. The values, however, given by Mr. Steven, are for *wire* of moderate carrying capacity, and are therefore open to the same objection as the writer's figures. With regard to the influence of the purity of the aluminium upon its conductivity, the subject has been fully investigated by Richards & Thomson, and their results are published in the *Journal of the Franklin Institute* for April, 1897. They



City and South London Railway Extensions.—General View of Power House.

found that while 99·75 per cent. aluminium has a conductivity of between 63 and 64 (copper 100), 99 per cent. aluminium has only a conductivity of 59—a drop of 5 points. The conductivity of the Snoqualmie-Seattle transmission line will, therefore, be under 59, since 1·5 per cent. copper is to be alloyed with the aluminium in order to improve its tensile strength.

To summarise these remarks:—

If the aluminium extraction companies are prepared to sell large amounts of aluminium of 59 points conductivity, in rod or bar form for 29 cents, or 14½d. per lb. in this country and in Europe, electricians have at their disposal for conducting purposes a metal which, at the present price of copper, is worth considering, though still the dearer of the two. The ratio as obtained by use of the formula given above, is

$$\frac{\text{Copper}}{\text{Aluminium}} = \frac{8{\cdot}93 \times 6{\cdot}415 \times 59}{2{\cdot}68 \times 14{\cdot}5 \times 100} = \frac{100}{115}.$$

If, however, the price asked for aluminium in such form be 15·85d. per lb., copper, in spite of the recent sharp rise in cost, is much the more economical metal for bare conductors.

Where covered conductors are required, there can be no question of rivalry between the two, until aluminium has fallen to one-half or one-third of its present value.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Continued from page* 900.)

Cork.—On Thursday last week Sir Francis Marindin and Major Cardew, inspectors of the Board of Trade, made an official inspection of the permanent way and power house of the Cork Electric Tramway and Lighting Company. They were accompanied by the Mayor of Cork, Mr. Maurice Healy, M.P., the city engineer (Mr. H. H. Cutler), Mr. Price (Harbour Board engineer), Mr. Kirkby (county surveyor), Messrs. Little and Astrom, on behalf of the British Thomson-Houston Company, Mr. Charles Merz, engineer of the Cork Electric Company, and several other gentlemen interested in the tramway and lighting scheme. A journey was made over the entire line, and proved highly satisfactory, no hitch having occurred. It is surmised that the inspector's report will be favourable, and the trams are expected to ply for public hire on Saturday next.

Darwen and Blackburn.—At a meeting of the Darwen Town Council it was resolved to purchase that portion of the Blackburn and Over Darwen Tramway Company's undertaking which is within the borough. The town clerk gave the details of the agreement between the Blackburn and Darwen Corporations and the tramways company.

Gateshead.—The Parliamentary Committee has received a letter from the secretary of the Electric Power Distribution Company, Limited, accepting the terms fixed by the Council at their meeting on November 26th, upon which the Council gave their approbation to the granting by the Board of Trade of a provisional order. The committee reported that notice had been given by the Gateshead and District Tramways Company to apply for a Bill authorising the company to construct the tramways within the borough as agreed upon between the Corporation and the company, and a similar notice had been given by the Electrical Power Distribution Company, Limited.

Gravesend.—Last week Mr. J. F. Albright, director of the Drake & Gorham Electric Traction Syndicate, addressed a special meeting of the Gravesend and Northfleet Tradesmen's Association on the subject of electric trams. Alderman E. C. Paine, J.P., presided, and after a short discussion, it was resolved to memorialise the Gravesend Corporation to support the present application for a provisional order.

Greenock.—A report on electric tramway haulage has been submitted to the sub-committee of the Greenock Police Board on tramway proposals by Mr. Fedden, the burgh electrical engineer. Mr. Fedden estimates the amount payable to the existing company for their lines from Rue End into Port Glasgow at £45,000. Conversion costs he estimates as follows:—End of Port Glasgow to Rue End Street, £33,000; half-mile new line Rue End to West Burn Street *viâ* Cathcart Square, with span wire from houses, £4,500 for track, and £2,500 for wires, &c.—£7,000; West Burn Street to west boundary line, £22,000; west boundary line to Ashton, £15,000; 18 motor cars, £9,000; six trailer cars, £1,800; feeders and contingencies, £3,000; value of existing tramways of Greenock Police Board, £15,000—total estimated capital, £150,800. Interest and sinking fund at 6 per cent., £9,000 per annum. In an estimate of revenue and expenditure, Mr. Fedden calculates that the balance of revenue over expenditure in the double line from Port Glasgow east boundary to Cardwell Bay would be £1,000 per annum at 1s. per car mile, and £4,300 at 1s. 2d. per car mile. In the double line from east to west boundary of Greenock, Mr. Fedden estimates a loss of £140 per annum on 250,000 miles at 1s., and a gain of £1,923 at 1s. 2d.; a gain of £1,860 on 330,000 miles at 1s., and a gain of £4,593 on 330,000 miles at 1s. 2d. In the third section, from Rue End Street to west boundary of Greenock, he estimates a loss of £1,653 per annum on 150,000 and £1,185 on 200,000 miles at 9d., and a gain of £340 and £1,940 on 150,000 and 200,000 miles respectively at 1s. He is of opinion that in the hands of the Police Board all the conditions of the tramway service would be improved, and advises that if the sub-committee should consider the taking over from the Greenock and Port Glasgow Tramways Company of any part of the undertaking, they should take over the whole of it, and in the near future extend their lines considerably to the south.

Hounslow.—The Heston-Isleworth District Council have decided to oppose the proposals for a light electric railway in Hounslow, put forward by the London United Tramways Company. The clerk advised the Council that the point had yet to be decided how far the Light Railways Act could be used for the construction of tramways.

Liverpool.—At last week's City Council meeting, Mr. Rutherford moved the adoption of the recommendation, "That the Tramway Committee be authorised to carry out the construction of the lines mentioned in the city engineer's report, dated October 14th, 1898, other than the line from the Dingle to Aigburth Vale, which has already been authorised by the Council, at an estimated cost of street construction works of £127,400." The scheme involved, he explained, the construction of 8½ miles of tramway where there were no lines at present, and 18¼ miles of conversion from horse tramway to tramway suitable for mechanical traction. Of the total cost the sums of £17,426 and £37,413 were for permanent way in the form of rails, &c., and £38,300 and £53,000 for paving and repaving within the statutory limits. Even if mechanical traction were not to be introduced, such was the state of the existing rails and streets that the work would have to be done, and with a form of wheel devised by the engineer the horse cars could run on the new rails, and there would be no dislocation of traffic.—Alderman Smith seconded.—Mr. Brownbill moved as an amendment, "That the construction of the lines mentioned be postponed until the Council shall have determined as to whether the overhead trolley system or the underground conduit system is to be finally adopted." This was a most important question, because upon their decision depended the system of propulsion to be carried out in Liverpool. The appearance of the overhead trolley system had been very much condemned. In several places that system had been abandoned in favour of the conduit.—Mr. Beloe seconded.—Mr. Petrie said that if they were to carry the people cheaply, they must adopt the overhead. The conduit system would interfere very seriously with drains, gas pipes, and electric mains.—Sir William Forwood said that as one who had spoken against the trolley system, he was bound to state he had changed his opinion, for the reason that the experienced engineer of the Overhead Railway, after making an investigation into all the systems of electric traction in use, had reported that the conduit was four times as costly to construct, and three times as costly to maintain, as the overhead, and that his opinion was that the trolley system was the best for a town like Liverpool. After further discussion Mr. Rutherford said that on the best and most recent figures he found that the conduit system if adopted for Liverpool would mean an additional half-million to construct and an additional ½d. per car mile to maintain. These two items meant an additional 1d. per car mile. What Liverpool needed was cheap traction, and the late Sir Arthur Forwood's promise of 1d. fares would have to be withdrawn if the Council were to say that the outside lines were to be on the conduit system. If, as was likely, both the overhead and the conduit systems were superseded in a few years by a car with an ideal accumulator, then they would certainly not be justified in now adopting the conduit, which was so much more expensive. He believed that no tramway rate would be necessary unless the Committee's programme of reconstruction was interfered with and the work delayed. On a vote the amendment was lost by 66 to 10, and the recommendation of the committee was adopted. Mr. Rutherford moved, and it was resolved, that the Tramways Committee be authorised to carry out the extension of the electric line of tramways from South Castle Street to Park Lane *viâ* Lord Street and Paradise Street, and that from Park Lane, along Paradise Street, a double line be laid up to the point where Paradise Street joins Lord Street, at an estimated cost of £8,300. Mr. Rutherford moved—"That the tender of the British Thomson-Houston Company, Limited, London, for the supply and delivery of six motor cars, for the sum of £554 9s. 6d. each, and six motor cars for the sum of £587 4s. 6d. each be accepted." The tender was adopted.

Liversedge.—The District Council has decided to support the application of the British Electric Traction Company for the laying of a tramway from Dewsbury to Cleckheaton.

London United Tramways Company.—The position which Ealing has taken up with regard to the proposed order for a light railway with electric traction connecting Acton with Hanwell is the same as towards the same company's proposals last year. At the last meeting of the Ealing District Council delegates from the Hanwell, Southall and Uxbridge District Councils attended, and appealed to the councillors to sanction the proposal in the interests of the western parts of the county of Middlesex. The London United Tramways Company have already an order for a light railway through the districts westward of Ealing, and residents in that part of the county are asking why Ealing should seek to bar the way of their advancement. The discussion after the deputation had left was carried on with great spirit, and a motion was brought forward by Councillor Griffin, a property and estate agent in the locality, that

the Council dissent, to which an amendment was moved that the engineer of the company be interviewed. Finally the amendment was lost by 7 votes to 8, and the resolution carried by the same figures.

Further particulars of the proposals of the London United Tramways Company to run a light railway from Brentford to Hampton Court show that the promoters are prepared to spend £40,000 on street widening and improving alone. The cars will be made to accommodate 63 persons each, and the speed will be regulated according to the localities passed through, the pace being heightened in the open country and lessened in the towns and villages. The fares proposed to be charged from Shepherd's Bush to Hampton Court will be 6d., or 10d. return, and low intermediate fares will prevail. Early trams will be run for workmen at half fares.

The London United Tramways Company's scheme, promoted under the Light Railways Act, for a light railway from Hanwell to Uxbridge in connection with their authorised lines, which has been passed by the Light Railway Commissioners, came before the Board of Trade on Wednesday. The Great Western Railway Company opposed the order. The Board was represented by Sir Courtenay Boyle, assisted by Mr. Hopgood, Sir Thomas Blomefield, and Sir Francis Marindin. After hearing the arguments for and against, Sir Courtenay Boyle said the decision of the Board of Trade would be given in a few days.

Manchester.—In reply to several queries put to him by councillors at last week's Council meeting, regarding the question of the conduit system, Mr. Alderman Higginbottom said that he was a mechanical engineer, and for years he had given deep study to every known system of electric traction, and he had kept himself thoroughly informed on every system of electric traction in all the engineering papers and scientific journals. It was on the results of these investigations that he based his views in support of the overhead system. Mr. Renold argued, in the local press, that the systems at New York and Washington had not received sufficient consideration by himself (the speaker) and Mr. Wordingham. It was true that neither he nor Mr. Wordingham had seen the systems referred to, but after reading the reports of deputations, electrical engineers, and experts, and comparing the capital outlay and the working details, they came to the conclusion that it was not necessary to see the systems at New York and Washington in order to arrive at the conclusion that it was not preferable to the overhead trolley system so far as Manchester was concerned. The reasons in favour of the overhead trolley system were (1) that the first capital cost per mile of track was £2,135, against £11,491 for the conduit system, or for the 67 miles required £144,000, against £773,897; (2) the working cost per car mile was a halfpenny more for the conduit system, or £14,000 a year; (3) the difficulties of construction of the conduit system in the narrow and congested Manchester streets; (4) nothing could be done until the leases of the Manchester Carriage and Tramways Company expired in April, 1901; (5) the consequence of that would be that the Corporation would have to do either as Glasgow did, viz., provide new horse cars, horses, depots, &c., or buy up the horses, cars, depots, &c., of the company, and continue working them with the present horse traction; (6) with the overhead system the Corporation could begin to equip now, and have everything ready by 1901, and would, therefore, not have a lot of horses, cars, &c., on their hands to dispose of at a big loss, as would be the case if they had to commence with horse traction. Mr. Renold, he said, had not disputed nor disproved any of his figures, which had been compiled from particulars provided by the best experts on the subject. Alderman Higginbottom then gave the experiences of experts in favour of the overhead system. Mr. Renold had stated that he (the speaker) had expressed the opinion that if the trolley system were adopted the profit would be £700,000, and if the conduit system were adopted the profit would only be £38,000. He had said nothing of the kind. What he had said was that the profit would be about £700,000, and that if the extra capital required for the conduit system, viz., £629,877, was spent, the interest and sinking fund alone on that extra capital would be about £38,000, and that the profit would be reduced by that amount. Mr. Renold asked why he had not referred to the report of Mr. J. Allen Baker to the London County Council, from which Mr. Renold quoted a lot of figures. He did not deal with that report because it was not made by Mr. Baker as an official, or under the direction of the London County Council, and because Mr. Baker's figures, compared with those given by electrical experts, were quite fallacious. Alderman Higginbottom then proceeded to deal with Mr. Baker's report, with the object of showing its conclusions to be unreliable. Continuing, he said the Corporation had entered into agreements with various local authorities on the basis of the capital cost for the overhead trolley system, and remarked that if the conduit system were adopted for the outside districts the capital cost would be prohibitive, and their agreements could not be carried out. In view of that, surely no one would contemplate using the conduit system outside the city. He added his conviction that if they carried out the proposal to open the overhead system in 1901 they would be acting in the best interests of the city, for they would find the system to be economical in construction, economical in working, and profitable in its returns on the capital invested. The minutes of the Electricity Committee were approved.

Newcastle.—The Tramways Committee recommend the Council to sanction the proposal that the Tramway Committee and any other members of the Council who are desirous of joining the Committee, should visit towns in which cable and electrical tramways were laid, one or two in particular having similar gradients to Westgate Hill. It is proposed that the places to be visited should be Edinburgh and Brixton, where cable lines are laid, and Middlesbrough, Leeds, Bradford, and Dover, where electricity is in operation.

Newcastle (Staff).—The Council has resolved that the amended design of the pole to carry the overhead wires for the Potteries Extension Tramways be not approved, and that the design of poles as erected at Bristol or Leeds be recommended to the British Electric Traction Company, Limited, for erection in the borough. The application of the Potteries Electric Traction Company for a provisional order for electric lighting is not to be proceeded with.

Norwich.—A recent report to the Town Council on the electric tramways shows that the total length of track completed at the end of November was 4 miles 2 furlongs 7 chains. A further length is constructing.

Northfleet.—The District Council last week had before it the application of the Gravesend and Northfleet Tramway Company for consent for a provisional order for the extension of the system and the use of electricity. The Council will consider the matter in committee with representatives of the company.

Salford.—The Council last week formally received the report of the sub-committee which visited Hamburg to see the electric car system there.

Twickenham.—The inhabitants in Twickenham along the suggested route of the proposed London United Tramways Light Railway have been stirred up to oppose by an old inhabitant, who, by letters, has been endeavouring to show that the line is not needed, and that the overhead wires will greatly impede the working of the fire escapes. It is also further urged that the Light Railways Act does not cover the construction of tramways. A petition is being circulated in Twickenham against the proposal on the grounds (1) that there is an ample service of omnibuses; (2) that Richmond Road is a crowded thoroughfare; (3) the gradient on the Twickenham side of Richmond Bridge is so steep that a tram terminus at the bottom would be dangerous; (4) that in 1879 a tramways Bill was thrown out because of this gradient; and (5) that the trams would seriously affect the value of property, &c. Both the London United Tramways Company and the Drake & Gorham Company have obtained many signatures to their petitions. A movement is also on foot to require that the bridges on the roads to be traversed shall be widened.

Warwick.—The General Purposes Committee reported to the Council against permission being granted for overhead traction for the local tramway, as suggested by the British Electric Traction Company, which has conditionally undertaken to purchase the Leamington and Warwick Tramway Company. The Council has resolved to appoint a Committee to confer with the Leamington Town Council.

West Bromwich.—At last week's Council meeting it was reported that a copy had been received of a Bill which was being promoted to empower the South Staffordshire Tramways Company to grant to the British Electric Traction Company, Limited, a lease of all or any part of the South Staffordshire Company's powers. The Mayor (Councillor S. Pitt) said the town clerk had advised him that, the council having resolved to take over the tramways in the borough, the Corporation must obtain a *locus standi* in the matter, and he therefore moved that the Council decline to consent to the application of the South Staffordshire Tramways Company, and that the town clerk be instructed to oppose the Bill so far as West Bromwich was concerned. The Mayor pointed out further that two committees sitting jointly were considering the question, but in view of the proposed Bill the resolution was necessary. The resolution was carried.

Wolverhampton.—At Monday's meeting of the Town Council the town clerk submitted the Parliamentary Bill for dealing with the tramways question, and the subjoined interesting figures as to cost, &c., were quoted. The town clerk said the total estimated cost for construction of the tramlines, for the equipment of cars, &c., the erection of depots, came to £210,121. This total was made up as follows:—

Permanent way	£136,000
Above ground equipment, trolley wires, car depot, cars, special plant, &c.	60,940
Proportion of electric plant, feeder mains to tramways ...	15,900
Land for new depot and alterations to existing depot, widening of Stubb's Lane, &c.	5,230
Total	£218,110
Less credit for five miles of existing track, proportion of harness, cars, and horses	7,982
Leaving the net total at	£210,121

That sum, it was explained, was exclusive of the purchase of the tramways, which would have to be settled by arbitration.

Worcester.—The Chamber of Commerce has been considering the question of extending the tramways in and around Worcester. The Chamber decided to approach the existing tramway company and the City Council with a view to their opening negotiations for connecting the adjacent villages with the city.

Wrexham.—On 6th inst. a meeting of the members of the Town Council was held to meet Mr. Allbright, the managing director of the company applying to the Board of Trade for a provisional order to provide electric tramways at Wrexham and district. Mr. Allbright said their first undertaking would be to take in hand the present tramway from Wrexham to Johnstown, a distance of 3½ miles, and widen the gauge to 3 feet 6 inches, and run it up Gutter

Hill to Rhos. Having described the route, he said that some of the streets were very narrow, but the difficulties were not too great. He instanced Dover, where some of the streets were equally as narrow, but there the trolley system, which they proposed to utilise in Wrexham, worked very well. The gradient was particularly steep at one spot, and no other system but the trolley system would overcome that difficulty. He had no doubt the company would be pleased to arrange with the Corporation to utilise their standards for the purpose of carrying the electric lamps of the Corporation, and that if satisfactory terms could be arranged, the company would take the motive power for the trams from the Corporation electric light station. Their poles would be about 40 yards apart, but they could make use of buildings in some of the very narrow places. The chairman thanked Mr. Allbright for his attendance, and said a special meeting of the Council would be held to consider the matter.

TELEGRAPH AND TELEPHONE NOTES.

America and French Cables.—A Reuter despatch from Washington, dated 13th inst., says that Rear-Admiral Sampson and General Henry have instructed the officers in command at various points on the coast of Puerto Rico to prevent the landing of a French cable.

American Telegraph Cables.—Our New York namesake draws attention to the necessity for an American cable in the Pacific, now that America has possessions there. It is necessary for both war and commercial purposes. In an interview, Senator Cullom, chairman of the Hawaiian Commission, expresses the opinion that America needed a cable to the Sandwich Islands, and that it eventually ought to be extended to the Philippines. A Bill will be reported to Congress during the coming session embodying this recommendation. "The cable should be built by citizens of the United States, and of American materials."

Liverpool and the Telephone.—The Liverpool Chambers of Commerce has resolved:—"That having regard to the present working of the telephone service under the dual control of the Post Office and the National Telephone Company, Limited, it is expedient in the judgment of this Council that the Government should acquire the undertaking of the National Telephone Company, Limited, on terms just and reasonable as between the public and the company's shareholders."

Pacific Cable.—It is stated by the New York correspondent of the *Morning Post* that the all-British scheme has been again revived at Ottawa by the publication of a letter addressed to Mr. Chamberlain by Sir Sandford Fleming. This document prepared by the most persistent advocate of a State-supported Pacific cable, is stated to urge the most ambitious scheme yet discussed. Sir Sandford Fleming's plan, as he commends it to the Colonial Secretary, is the establishment of a State system of cables beginning at Vancouver, crossing the Pacific to New Zealand and Australia, and then crossing the Indian Ocean to the coast of South Africa. From there a cable would be laid across the Atlantic to touch again Canadian soil, where it would join the Trans-Atlantic lines. "Such a system," says Sir Sandford Fleming, "would connect all Great Britain's possessions and her coaling stations." He advocates the abrogation of the agreement with the Eastern Extension Telegraph Company so that cable communication between Canada and Australia might be connected at Hong Kong. His letter maintains that it is essential that the cables be not laid in shallow seas and do not touch foreign territory.

The Glasgow Telephone Question.—A letter appears in the *North British Daily Mail* from the Ericsson-Bell Telephone Company:—"As you have published in your issue of 2nd inst. our letter of November 25th, 1898, to Sir James Marwick, the town clerk, Glasgow, withdrawing our quotations of September 23rd, 1897, for multiple switchboards, telephones, &c., we wish you to make it generally known that the contract made by Messrs. L. M. Ericsson & Co., Limited, at Stockholm, with the National Telephone Company, Limited, London, was signed on October 3rd, 1898, at Stockholm, without our knowledge or consent. The agreement made is not to sell telephone apparatus to or for any municipal corporation, or any licensee of Her Majesty's Postmaster-General, in connection with exchange lines within the British Isles, except through the National Telephone Company, Limited, at London."

The City Police and Telephones.—At last week's meeting of the Court of Common Council, Mr. A. C. Morton moved that it be referred to the Police Committee to consider and report as to the desirability of placing the several police stations in the City upon the telephone service, and said it was a matter of surprise to him to find that that excellent means of communication had not been made use of in the metropolis in the same way as it had been by some of the more enlightened cities and towns in the provinces. The resolution was agreed to. With reference to the proposed conference of the metropolitan local authorities on the subject of the telephone service, the chairman of the Streets Committee said that a date had not yet been fixed.

The Telegraph Wire Export Trade.—November has generally been a very quiet month as regards the export trade of this country in telegraph wire and apparatus connected therewith, and the returns just issued show that the past month has proved no exception to the rule. From £89,313 in October last the value of the shipments last month fell to £39,837, which compares, however, with only £34,341 in November last year. The returns for the year to date must, however, be considered satisfactory, a total of £976,558 being recorded for the 11 months ending with November last, as compared with £828,962 in the corresponding period of last year, and only £743,276 in the first 11 months of 1896.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
West Indies—		
St. Lucia-St. Vincent ..	Sept. 24th, 1898 ...	...
Amazon Company's cable—		
Cable beyond Gurupa ...	June 8th, 1898 ...	...
Dartmouth-Guernsey ...	Dec. 1st, 1898 ...	...
New York-Hayti	Nov. 30th, 1898 ...	...
Para-Maranham	Nov. 25th, 1898 ...	...
Saint Louis-Noronha	Oct. 17th, 1898	Dec. 12th, 1898
LANDLINES.		
Majunga-Tananarive	... Dec. 6th, 1898	... Dec. 7th, 1898.
" "	... Dec. 10th, 1898	... Dec. 11th, 1898
All Siberian landlines	... Dec. 10th, 1898	... Dec. 10th, 1898

CONTRACTS OPEN AND CLOSED.

OPEN.

Beckenham.—December 17th. The Urban District Council invites tenders for water-tube boilers, alternators, transformers, pipe work, feed pumps, arc lamps and posts, cables and other street works, travelling crane, &c., &c., for the electric lighting scheme. Specifications, &c., from Messrs. Wilson & Story, 66, Victoria Street. See our "Official Notices" November 18th.

Burnley.—January 10th. The Corporation want tenders for underground electric light cables and switchboard. See our "Official Notices" this week.

Cumberland.—January 2nd. The Visitors' Committee of the Cumberland and Westmorland Asylum invite tenders for the supply and erection of an electric tell-tale clock with 30 stations. See our "Official Notices" this week.

Dublin.—December 28th. The Corporation is inviting tenders for the supply of a high tension single-pole switchboard. Specifications and drawings can be seen at the offices of Prof. Kennedy, 17, Victoria Street, S.W., and copies can be obtained from the City Engineer. See our "Official Notices" this week.

Edinburgh.—January 2nd. The Council invite tenders for switchboard and boosters for the Macdonald Road lighting station. See our "Official Notices" this week.

Fleetwood.—The North Euston Estate Company, Limited, wants tenders for an installation of wiring, switchboards, &c., for the electric light, current being taken from the town supply; also for electric bells. See our "Official Notices" December 2nd for particulars.

Glasgow.—January 3rd. The Corporation invites tenders for generating plant at one or other of their new electricity works:—Two engines each of 200, and two of 400; three of 1,100, and two of 2,200 indicated horse-power, with dynamos and condensing plant. Specifications, forms of tenders, &c., from Mr. Chamen, city electrical engineer. See our "Official Notices" this week.

Leeds.—December 29th. The Council is inviting tenders for underground conductors, switchboards, &c., in connection with the electric tramways. Particulars from the city engineer or Messrs. Hopkinson & Talbot, 26, Victoria Street, S.W. See our "Official Notices" December 9th for particulars.

Londonderry.—December 24th. The Corporation wants tenders for the supply of arc lamp globes and carbons, for the year ending December 31st, 1899. See our "Official Notices" this week.

Stirling.—January 2nd. The Burgh Commissioners are inviting tenders for Lancashire boilers, engines, dynamos, pumps, piping, crane, accumulators, switchboard and boosters, arc lamps, and various other apparatus, &c., for the electric lighting of the town. Consulting engineer, Prof. A. B. W. Kennedy. See our "Official Notices" December 9th for particulars.

Sunderland.—December 30th. The Corporation wants tenders for the supply of three 125-kw. direct current high speed steam dynamos, 460 volts. Borough electrical engineer, Mr. J. F. C. Snell. See our "Official Notices" December 9th for particulars.

CLOSED.

Barrow.—The Electric Lighting Committee has accepted the tender of Messrs. Crompton & Co., Limited, for the supply of 21 arc lamps, mains, and fittings, &c., subject to the columns being of the same type as used at Edinburgh, instead of the type tendered for. Total, £1,154. But for certain unforeseen difficulties, the plant would be running by this time.

Bradford.—We understand that Messrs. Siemens's tender for two steam engines and dynamos for the Valley Road electricity works is recommended for acceptance at £4,150.

France.—The French Post and Telegraph authorities in Paris have just placed contracts as follows:—M. Grammont, of Pont de Cheruy (Isère), 80 kilometres of submarine cable core, at £2,496; Les Forges de Commentry-Fourchamboult, Paris, 30 tons of galvanised iron wire, 5 mm. diameter, at £298, and 100 tons ditto, 8 mm. diameter, at £994.

Liverpool.—As will be seen from our "Traction Notes," the Corporation has given an order to the British Thomson-Houston Company for electric cars. The overhead work for the Aigburth Road electrical line is to be carried out by Messrs. R. W. Blackwell and Co. for £1,870.

FORTHCOMING EVENTS.

Thursday, December 15th, 1898.—At 8 p.m. The Institution of Electrical Engineers. "Electric Inter-communication in Railway Trains," by W. E. Langdon, Vice-President.

Friday, December 16th, 1898.—At 7.40 p.m. North East Coast Institution of Engineers and Shipbuilders. Paper on "An Improved Method of Strengthening Copper Pipes," by Mr. T. Messenger.

Tuesday, December 20th.—At 8 p.m. The Institution of Civil Engineers. Further discussion on "The Ventilation of Tunnels and Buildings." By Francis Fox, M.I.C.E. And, time permitting, "High-speed Engines." By John Handsley Dales, A.M.I.C.E.

Thursday, December 22nd.—At 8 p.m. The Institution of Electrical Engineers. "Telegraphy by Magnetic Induction." By S. Evershed, associate. The discussion on Dr. Lodge's paper, "Improvements in Magnetic Space Telegraphy," and on Mr. Evershed's paper, will be opened by Dr. Fleming and Mr. Preece, with experimental demonstrations.

NOTES.

Tesla and his Critics.—Our contemporary the *Electrical Engineer* (N.Y.) has given offence to Mr. Tesla by an article entitled "Mr. Tesla and the Czar." The connection between these two famous personages is not at first sight apparent, but it appears that both are Slavs, and Tesla's new scheme for aerial power transmission strikes our contemporary as belonging to the same class as the Disarmament scheme of the Czar. The aims of both Tesla and the Czar, says our contemporary, "appear wholly noble, their thoughts are beautiful, and if they fail, as they probably will in some material and vital respects, the world is certainly none the worse off for what they actually accomplish." Though the article is not wholly unappreciative of the good work which Tesla has accomplished, it twits Tesla with the number of his unfinished inventions, and unnecessarily perhaps emphasises the assertion that Profs. Brackett and Dolbear have virtually classed him as a humbug. Tesla has written in reply that by this last straw our contemporary has strained his Christianity and philosophy to the breaking point, demands proofs of the animadversions of the distinguished professors, which he says reflect on his honour and honesty, and through him upon a number of American Universities, who have conferred great honours upon him. The *Electrical Engineer* replies by pointing out the support that it has given to Mr. Tesla and his inventions since the beginning of his career, and professes that its mild criticism and mild banter was a sign of true friendship. We confess that we don't think that there was anything much in what our contemporary said, but the way in which it was put might be expected to give offence to a man of Tesla's poetic sensibility.

Wireless Telegraphy.—The *Standard* Vienna correspondent telegraphs that experiments were made a few days ago at Pola, and are shortly to be repeated, with an improvement of Marconi's system of wireless telegraphy. "It is already possible to determine the presence and course of a vessel distant from six to eight English miles. The improvement is the invention of a young student at the Buda-Pesth Polytechnic, named Bela Schefer. The next trials will be made in the presence of Admiral Baron Spaun and several naval engineers."

Trowbridge's Experiments on Spark Tension.—In the *Scientific American* Prof. Trowbridge describes some recent experiments on the effect of very high electromotive forces upon the discharge of electricity through air at ordinary pressures, which lend some support to Tesla's scheme of transmission of currents through the air. In his experiments made in January of this year (Electrical Review, Vol. 42, p. 135), Trowbridge used an apparatus capable of producing 1,200,000 volts, and up to this pressure he found the spark length strictly proportional to the E.M.F. He has now constructed an apparatus capable of producing 3,000,000 volts, and he finds that with the high pressures he now can use, the air behaves quite differently. When an E.M.F. of 1,500,000 volts is exceeded, the spark no longer increases in proportion to the E.M.F; for instance, 3,000,000 volts produces a spark of about 7 feet in length, when it should excite one at least 10 feet long. The explanation of this falling off is that leakage takes place from both terminals in the form of brush discharges to the walls of the room. He finds that the resistance of air is immensely reduced by these high pressure brush discharges; so much so, that a spark preferred to pass through 5 cm. of this dissociated air to passing through 1,000 ohms of copper sulphate solution. Trowbridge believes that his apparatus would have to be placed 30 or 40 feet above the earth to prevent this lateral leakage, and give the full effect of the voltage in length of spark. Tesla's whole generating plant, he thinks, will have to be suspended on the balloon, not the terminals only, as Tesla proposes. This feat will not be easy.

The Report of the "Deutsche Gesellschaft für Elektrische Unternehmüngen. Frankfort a. Maine."—This company has much extended its holdings in promising electrical developments during the past year. The £250,000 upon the original share capital has been entirely called up, and £500,000 new share capital has been created, of which £125,000 has been paid, and is now ranking for dividends. This new capital was issued at 110, and the profit on the issue has been added to the reserve fund of the company. The total share capital is now £750,000, of which one-half has been paid up. The operations of the various undertakings in which the company is interested produced in the financial year 1897-98, a gross profit of £16,750 upon its investments as against £7,770 in 1896-97. The net profit is £15,390, and, with the amount carried forward from the previous year, permits of a 7 per cent. dividend being paid. The company now owns all the share capital in lighting and traction companies at Bockenheim, Gotha, Limburg and Homburg, and is largely interested in similar undertakings at Essen, Wiesloch, Kubel, Augsburg, Mülheim, Kalk, and Kiev. The detailed report of this company's operations, which will be found in the *Elektrotechnische Zeitschrift* for October 20th, is worthy of the attention of English capitalists and bankers, for it illustrates well the methods of German finance referred to in our issues of October 14th and earlier date. To raise the capital necessary for all the electrical undertakings named above by English methods of company finance would have involved large advertising, underwriting and promotion expenditure. The German system avoids all this. The investor hands over his capital to responsible experts, and they invest it in subsidiary companies as they think best. The appeal to the ignorant public is thus unnecessary, and the consequent saving in flotation expenses, and gain to the electrical industries, must be immense.

Shock Fatality.—It is stated that on the 13th inst. an inquest was held at Southampton on the body of a man named Day, aged 30, who was killed on Monday while laying electric mains for the Corporation. The deceased, of London, was in the employ of Messrs. W. T. Glover & Co., who were the contractors for the cables. He was engaged at work on the cables, when somehow or other he received a shock and was instantly killed. The inquiry was adjourned for a week.

Honours.—His Imperial Majesty the Shah of Persia has been pleased to confer the second class of the order of the Lion and the Sun upon Mr. T. W. Stratford-Andrews, who is a director of the Indo-European Telegraph Company.

The Equilibristat.—Mr. Don J. Whittemore, engineer of the Chicago, Milwaukee, and St. Paul Railway, has described a new form of level for making observations on a railway track when running. A glass tube of moderate bore (the illustration seems to show a tube of about ¼ inch bore) is bent into an inverted ∩, and the ends enlarged to about three times their previous diameter for a short length. These lower ends are again contracted and sealed into the upturned ends of a horizontal tube of small bore, the whole forming a continuous tube of varying calibre. Mercury is placed in the lower part so as to fill the horizontal tube and half fill the enlarged chambers, and above the mercury on each side is placed spirit to half way up the vertical limbs. This arrangement forms a very easily observed and sensitive level, since small differences of level in the mercury on the two sides occur over the areas of the two enlarged chambers, and cause considerable displacements of the spirit. The movements of the free menisus of the spirit in the small parts of the vertical tubes being so much greater than those of the mercury, are very conspicuous. The fine bore of the tube connecting the chambers at their lower ends prevents rapid movements of the mercury, and produces practical aperiodicity. The inventor used his instrument mainly for two purposes: to examine, while running, the superelevation of the outer rail on curves, and to indicate gradients. In the former case if the superelevation is correct for the particular speed at which the train is travelling round the curve a level placed athwart the train should show no displacement, and displacements will be to the right or left as the superelevation is excessive or deficient. In the latter case the level placed in the length of the train will indicate directly the gradient of the line. The use of extended surfaces in levels of this kind producing large displacements in a fine connected tube for small differences of level is not new, but we have not seen it applied exactly in this form before. The original paper in the *Journal of the Western Society of Engineers* contains a good many details we have omitted. The instrument appears to be a very practical success, and has been called "The Equilibristat."

A New British Columbian Copper Company.—The recent rise in the price of copper, and consequent difficulty experienced by consumers in covering their requirements at reasonable rates, lends interest to the prospectus of the "Le Roi Mining Company," capital £1,000,000, which has been formed to purchase and develop the Le Roi Copper Mines at Rossland, British Columbia. The Marquis of Dufferin is on the board, and one certainly cannot regard him as a mere decoy, or as a promoter's puppet. The purchase price to be paid for the mines, which cover 70 acres, is £950,000, payable in cash or shares; the balance of £50,000 will be used as working capital. The mines have already been worked by the vendor companies, and 56,000 tons of ore has yielded 700 tons copper, 81,000 ounces silver, and 85,000 ounces gold. The average value was, therefore, $31 per short ton. A smelting plant is already in existence at the mines. The present output is 120,000 tons ore per annum, worth (presumably at present prices, which will decline) £6 per ton, and costing only £3 per ton for mining, local, and freight charges. The profits on the present output are, therefore, equal to £360,000 per annum. The noteworthy feature of this ore appears to be its high contents of gold, which is present in much larger quantity than in the copper ores of the famous Butte Mines at Montana. We hope this company may prove as successful as the prospectus would serve to indicate, and that some of the rich mattes obtained by smelting the ore from the Le Roi Mines may be electrolytically refined by English firms in this country.

Keely Redivivus.—Our contemporary, *Electricity* (New York), has a note in its issue for November 30th as follows:—"The Keely Motor Company directors held a brief session after attending the funeral of the inventor in Philadelphia on the 23rd ult., and adopted resolutions expressing faith in the ultimate success of Keely's alleged discovery, and suggesting that Thomas A. Edison, the electrical inventor, be invited to assist in completing the work." Evidently Edison has honour in his own country. Another exchange says that Edison will be "otherwise engaged."

The Growth of Electric Power Transmission.—A short but interesting article in the columns of our New York contemporary, the *Electrical Engineer*, is devoted to showing what important advances have been made in the United States in the matter of electric power transmission, more especially since the introduction of the multiphase system and the induction motor. Our contemporary says that it is hardly more than seven years ago that electrical manufacturing firms first tried to establish a special department for the application of electricity as a motive power for other purposes than traction, and that at first the results were not as encouraging as had been hoped, owing to the limitation of distance imposed by the use of direct current machinery and the unsuitability at that time of alternating current machinery for motive power work. It was in 1893 that the first important multiphase transmission plant was installed, and since then the progress has been rapid and continuous, both for multiphase and direct current plant. Our contemporary quotes some figures supplied to it by the General Electric Company, which will be interesting to our readers, and says that this company established a mining and power department in 1889, but did only a moderate business in the first few years. In 1892, however, power apparatus to the extent of 13,719 horse-power was sold; in 1893 the company sold apparatus to the extent 18,762 horse-power; in 1894 of 42,379 horse-power; in 1895 of 46,727 horse-power; in 1896 of 75,000, and in 1897 the aggregate horse-power of the power apparatus sold by the General Electric Company amounted to 83,000. Altogether, up to the end of January, 1897, the company had sold power apparatus to the extent of 279,587 horse-power, a total which undoubtedly shows how important a business has been developed in the United States, and which should serve as an incentive to our manufacturers to push this department of the applications of electricity more vigorously than they have done hitherto.

English and American Machine Tools.—We are glad to find the *Engineer* advocating American methods in certain directions connected with the design of machine tools. This direction is largely handiness and specialisation. We would not construct lathes so light as the American article, nor would we abandon the English slide rest, but it is in the many small and special tools that American tool makers really do shine. Our contemporary finds that since the strike manufacturing engineers are purchasing improved machinery. It would appear that much of the use of effete tools was due to the restricting action of trades unions, and that now this has been removed, and improved tools can be used to pay, they will be purchased. The cause of our contemporary's remarks was the absence of English tools from the recent cycle trade exhibition. Many American tools are rapidly becoming more English in their solidity of build, and they are also well finished. In small tools American makers are particularly good, and we have nothing to compare at the price with their gauges and small hand tools. We believe there is a daily opening field for these if some English firm would enter it on the American system of making to quantity. Perhaps the present is hardly the time for advocating new departures when our shops are all so busy, but the adage, "When at peace prepare for war," comes in well, and times will not always be so busy as they now are.

Opening of the Eccles Electricity Works.—On Wednesday the municipal electricity works were publicly inaugurated by Alderman Kendall, the chairman of the Electricity Committee. At the dinner held in the evening, the chairman, Alderman Kendall, proposed the toasts, "The Queen" and "The Prince and Princess of Wales." Mr. Alderman Wilkinson proposed "The Army, Navy, and Reserve Forces," and this was responded to by Captain Andrew. "The Corporation of Eccles and the Electricity Works" was proposed by Mr. Alderman Higginbottom, and the Mayor (Dr. Hamilton) and the chairman responded in suitable terms. Mr. S. V. Clirehugh acknowledged the toast "The Consulting Electrical Engineer," proposed by the Mayor. Messrs. Fawcus and Browett replied for "The Contractors and the Electrical Industry," Messrs. H. Edmunds and C. H. Wordingham for "The Visitors," and Mr. H. Alabaster responded for "The Press." We understand that the undertaking commences with the very satisfactory number of 45,000 lamps applied for.

The City Company and Competition.—We do not propose at this moment to enter into the intricate and debatable question of electric lighting competition. The entire matter will be raised soon enough by the promised debate in the forthcoming session of Parliament, in connection with the several large power schemes for which Bills are sought. We may then have occasion to refer to it at length. Just now, however, we cannot overlook the state of affairs which exists in London, and particularly as regards the area supplied by the City of London Company. Several electricity supply companies are anxious to get powers to compete with the City Company on its own ground, and the Court of Common Council has informed them that they have not the power to consent to such competition being introduced, the terms arranged in the original agreement with the City Company being presumably responsible for this. The intending competitors are, however, seemingly determined to have the matter threshed out before the Board of Trade or a Parliamentary Committee, for they are, as will have been seen from our list of the notices of applications, continuing their applications for provisional orders for the City district. One of the companies—the Charing Cross and Strand Electricity Supply Company—who have, we believe, given a fair measure of attention to the wants of their consumers, have recently been displaying considerable energy by getting ratepayers and others to sign a memorial in favour of their proposal to compete with the City Company. A copy of this memorial, with the names of 5,000 ratepayers and others who have signed it, is before us. It is, of course, a bulky thing, and seems to show that the dissatisfaction with the existing electric lighting service is widespread. The list includes a large number of the principal bankers, insurance societies, and owners of property. The points set out in the memorial are that monopoly is a bad thing, that the rates are excessive, that the Charing Cross Corporation gives a more economical, steady, and efficient service, that the low tension system is safer, and that it is the best adapted for arc lighting and motive power purposes. We should not be surprised to hear that a good proportion of those whose names are attached to this memorial, signed it purely and simply because they thought that the City Company would shake itself together and supply a more satisfactory light at a lower rate. As to whether they have considered the merits and demerits of competition in such a matter as electric lighting, well, we have our doubts. However, that is not the point. The memorial gives evidence of the feelings of the public toward the Bankside Company. The company has had the matter in its own hands for a long time, but has failed to find a remedy. It now finds itself confronted with the Court of Common Council, the City public, and companies who are anxious to come to the assistance of the consumer.

The Brush Multi-Circuit Arc Machine.—The *Electrical World* says that patents Nos. 613,880, 613,881 and 613,882, issued November 8th, 1898, to Mr. C. M. Green and assigned to the General Electric Company, cover the principles and details of the multi-circuit arrangement of the Brush constant-current arc machines. This arrangement, which is now well known to central station men, consists of a division of the external load into two or more parts, these parts being separately connected in between the several sections of the commutator. The arrangement is such that all parts of the load and of the machine windings are in series, the circuit being first through one section of the armature windings, then out and through one section of the load, back and through the next section of the armature windings, then through the next section of the load, &c., according to the number of circuits, and finally back to the starting point. Thus, in a 160-light four-circuit machine, for example, the potential rises about 2,000 volts on one section of the machine, falls again to its original value in one section of the load and rises again, so that the maximum difference of potential between any two points of the circuit is only 2,000 volts, instead of the 8,000 that would be obtained without this arrangement. This gives a great reduction of the breaking-down stress on the insulation under ordinary circumstances, but gives practically the full voltage of the machine across any accidental opening in the circuit.

Driving Ropes.—A note in the *Engineering Times* states that in an experiment with different ropes, equal lengths of 1 inch rope, fixed one end to a spring balance, and passed over a 26 V-groove pulley, running at 54 revolutions per minute, gave the following results, the loose end having a weight of 7 lbs. to help the grip:—Manila, 136 lbs.; Italian hemp, 140 lbs; cotton, 146 lbs.; paper, 502 lbs. At the same peripheral velocity, with a pulley of 54 inches diameter, cotton pulled 500 lbs., the smaller pulley being clearly undesirably small, and the ropes being insufficiently flexible to bed properly in the grooves. No information is given as to what a paper rope is. Paper is a term of very loose application, and one which is apt to be used for effect. We presume some fibrous cemented compound is meant. The same writer discusses the question of three or four strand ropes, but we thought this had passed beyond the realms of controversy, and been settled entirely in favour of the three-stranded rope, which cannot pull out of shape in the way a four-strand rope will do.

Meldrum's Steam Separator.—In a new separator, introduced by Messrs. Meldrum Bros., the steam pipe continues past the separator in the same direction as it entered. It consists of an enlargement in the pipe into which the steam enters and out of which it flows by a pipe projecting inwards, but the open end of which is covered by a cone. This cone is placed centrally with point towards the incoming steam. The point of the cone is open and allows the central portion of the steam current to pass straight forward. The outer portion is deflected by the cone, which allows the water to proceed by inertia towards the dead end while the steam doubles round the base of the cone and gets into the outlet pipe. The idea is based on the well-known greater dryness of the core of the stream in the pipe, only the wetter outside portion being separated. The collected water is drained off in the usual way. The instrument is variously constructed on the above general lines, and is applied also as an antiprimer inside steam boilers. The apparatus is simple, and should be effective. It does not err on the side of complication, but has simply one sharp reversal of flow, which is all that is required if properly arranged.

The Borough Polytechnic Institute.—By way of recognising to some extent the eminent services rendered by the chairman, Mr. Edric Bayley, to this Institute, and as a mark of appreciation for his liberal contribution of £2,000 to the building fund, the governing body has decided to call the new range of building comprising the School of Cookery, the Physics Laboratory, and Physics Lecture Theatre, by his name, and these schools will accordingly be named "The Edric Bayley Schools." The formal opening of this important addition to the Polytechnic buildings, as well as of the new Gymnasium, took place on the 1st inst.

Electrical Stage Machinery at Drury Lane Theatre.—The first section of the electrical stage appliances at the Theatre Royal, Drury Lane, designed by Mr. Edwin O. Sachs, was completed on Tuesday. The area of the stage, movable by mechanical power, now exceeds 1,100 square feet. Mr. Sachs's installation primarily comprises a series of large "bridges," with the aid of which the finest terraces can be formed in a few seconds, or the deepest caves arranged for underneath the stage by simply pressing a button. Whole scenes, says the *Times*, can be rapidly raised or lowered and transformations made with the greatest ease. The introduction of modern mechanism on these lines will open an entirely new era in the mounting of plays.

The Royal Society.—Among the papers down for reading yesterday afternoon were the following:—Prof. Dewar, F.R.S., (1) "Application of Liquid Hydrogen to the Production of High Vacua, and their Spectroscopic Examination." (2) "The Boiling Point of Liquid Hydrogen Under Reduced Pressure." Prof. O. Masson, "Ionic Velocities." Prof. Ramsay, F.R.S., "Note on the Densities of Atmospheric Nitrogen, Pure Nitrogen, and Argon." Prof. Ramsay, F.R.S., and Dr. Travers, "The Preparation and Some of the Properties of Pure Argon." Mr. C. E. S. Phillips, "The Action of Magnetised Electrodes upon Electrical Discharge Phenomena in Rarefied Gases." Preliminary note.

London Smoke and its Cure.—Mr. Alfred Davis writes to the *Pall Mall Gazette* on this subject in the following terms:—

I read with much interest the account of a meeting convened by Sir W. B. Richmond, R.A., in reference to the smoke nuisance. The newly formed committee deserve the thanks of every citizen in their effort to abate the nuisance; and no doubt their example will be followed up in all our large centres. But it appears to me that they might go further than they at present propose to do. They intend to insist on the abatement of the nuisance where it may be found to exist; but would not their hands be greatly strengthened if they could at the same time suggest the remedy? To my mind there can only be two remedies:—

1. The compulsory use of smokeless coal; and this, for obvious commercial reasons, is impracticable.

2. The adoption of an effective smoke consumer.

Such consumers do exist, but although a good deal of money has been spent (especially in the North) in finding one really effective, it is only recently that an invention has been made which combines cheapness with efficiency.

I have had the opportunity of examining this invention within the last fortnight. It consists simply of the application of the incandescent principle to asbestos blocks placed behind the bridge of the furnace, thereby consuming entirely the gases given off by the burning coal in front of the bridge, and not only destroying all smoke, but also securing a great economy in the amount of coal consumed. As it can be fitted to almost any boiler at a very nominal cost, there cannot be any further excuse for smoky chimneys in factories.

Electric Haulage on Canals and Rivers.—A company has just been formed in Brussels, with a capital of £60,000, to be known as La Compagnie Générale de Traction Electrique sur Les Voies Navigables, to acquire and exploit the patents of Messrs. Denèfle, Gaillot & Papot, relating to a system of electric haulage on canals and rivers.

Lectures.—At the next meeting of the Royal Institute of British Architects, the following lectures will be delivered and discussed:—"The Application of Electrical Power to Practical Purposes in Buildings," by H. R. J. Burstall, M.Inst.C.E. "Some Practical Hints on the Production and Use of Electricity for Lighting Country Houses," by Bernard M. Drake, M.I.E.E. The proceedings will be printed in full in the *Journal* of the Institute.

Scholarship.—On the nomination of the council of University College, the David Salomons scholarship, granted by the Institution of Electrical Engineers, has been awarded to Mr. H. J. Tomlinson, a student in the Pender Electrical Laboratory of University College, London.

Appointment Vacant.—The Carlisle Corporation wants an assistant electrical engineer at £130 per annum. See our "Official Notices" this week.

Royal Institution.—Among the list of lecture arrangements before Easter are:—The Right Hon. Lord Rayleigh, seven lectures on "The Mechanical Properties of Bodies." The Friday evening meetings will begin on January 20th, when a discourse will be delivered by Prof. Dewar on "Liquid Hydrogen."

Appointment.—Mr. M Elroy has been appointed secretary of the Tramways Department of the Manchester Corporation at a salary of £300 per annum.

Electricity in Japan.—So far as electrical science is concerned, Japan is as modern as she has long been in technical instruction. In 1896 (say *Industries and Iron*) there were 20,000 kilometres of telegraph lines and 1,122 telegraph offices, the number of messages sent being 22,500,000. There were 870 kilometres of telephone lines. In Tokio are five central stations and 40,000 lamps; also two companies producing current for traction purposes; they produce about 30,000 H.P, and transmit to a distance of 55 to 60 kilometres.

Fatality.—On 7th inst. a coroner's jury at Manchester returned a verdict of "Accidental death" in the case of Wm. Orr, an electrical engineer's linesman, who, while employed fixing the overhead trolley wire at Ashton for the electric tramways, fell to the ground through the breaking of the wire, and received injuries to which he subsequently succumbed.

NEW COMPANIES REGISTERED.

Land and Water Electric Power Syndicate, Limited (59,806).—This company was registered on December 6th, with a capital of £10,000 in £1 shares, to acquire the business carried on at Eel Pie Island, Twickenham, under the style of "Kerbey Bowen," to adopt two undescribed agreements, and to carry on the business of launch, boat, yacht, and shipbuilders, dock and slip owners, electricians, engineers, suppliers of electricity, &c. The first subscribers (each with one share) are:—A. A. Cooper, 200, Barry Road, East Dulwich, S.E., clerk; E. R. Baines, 47, Boswell Road, Thornton Heath, clerk; I. H. Campion, 8, Marlborough Road, Lee, S.E., clerk; F. B. Conyard, 151, Carlton Road, Gospel Oak, N.W., clerk; S. B Saunders, accountant, and T. H. Greenwood, student, Bush Lane House, Cannon Street, E.C.; K. Bowen, Palace Chambers, Westminster, engineer. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first; qualification, £250; remuneration, £30 each per annum for the first year, and afterwards 10 per cent. of the net profits divisible, provided 10 per cent. per annum is paid.

Dowsing Radiant Heat Company, Limited (59,842).—This company was registered on December 8th, with a capital of £12,000 in £1 shares, to acquire, own and work certain patents, inventions, and concessions relating to heating and lighting by electricity for hygienic, therapeutic, and general purposes. The first subscribers (each with one share) are:—William Conolly, gentleman, and Mrs. Elizabeth E. Conolly, Buckhurst, Redhill; Arthur C. Newstead, gentleman, and Mrs. Christina J. Newstead, Bromley, Kent; Herbert J. Dowsing, 24, Budge Row, E.C., electrical engineer; Frederick W. G. Conolly, Botolph House, Eastcheap, E.C., clerk; Mrs. Louisa Dowsing, Uxbridge House, Ealing, W. The first directors are Wm. Conolly, Arthur C. Newstead, and Herbert J. Dowsing; remuneration, 100 guineas each per annum and 10 per cent. of the net profits, divisible. Registered office, 24, Budge Row, E.C.

Anti-Vibration Incandescent Lighting Company, Limited (59,857).—This company was registered on December 9th, with a capital of £25,000 in £1 shares, to acquire and take over the businesses of the Anti-Vibration Incandescent Lighting Company, Limited, and the Acme Unbreakable Chimney Company, Limited, and to carry on the business of gas and mechanical engineers, electricians, plumbers, gas and electrical fitting manufacturers, &c. The first subscribers (each with one share) are:—Wm. Spinks, Ardleigh, Horsforth, civil engineer; Lewis Notley, Spen Lane, Kirkstall, engineer; Thomas R. Sanders, Lindenhurst, Halifax, gentleman; Thomas Redman, The Priory, Bolton, Bradford, engineer; George E. Rawnsley, Bradford, solicitor; George E. Poskett, Harrismith, Orange Free State, teacher; Thomas Crowther, Fern Bank Drive, Bingley, draper. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £1,000; remuneration as fixed by the company. Registered office, 12 and 14, Westgate Arcade, Bradford.

Canadian, British Columbian and Dawson City Telegraph Company, Limited (59,864).—This company was registered on December 9th, with a capital of £300,000 in £5 shares, to acquire all or any of the shares, debentures, or other securities, of the Dawson City and Victoria Telegraph Company, Limited (incorporated in Canada), and to construct, build, lay, equip, maintain and operate a telegraph line from Victoria, British Columbia, to Dawson City. The first subscribers (each with one share) are:—George T. Tilbury, 215, Piccadilly, W., clerk; Frederick W. Phipp, 20, Grosvenor Park, Camberwell, secretary; Charles A. Goffin, Minehead, Ouseley Road, Balham, secretary: Geo. E. Cripps, 106, Cambridge Road, Kilburn, clerk; Cecil R. Sims, 4, Elm Grove, Cricklewood, journalist; Wm. Young, 8, New Street Square, E.C., secretary; Miss Florence K. Smith, 70, Brook Green, Kensington, W. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £500; remuneration, £350 each per annum, and £450 for the chairman.

CITY NOTES.

NEW ISSUES.

The Canadian, British Columbian, and Dawson City Telegraph Company, Limited.

This company, which has been incorporated with a capital of £300,000, offered this week an issue at £95 of £225,000 5 per cent. first mortgage debenture stock. The objects of the company are to construct and work telegraph lines from the city of Victoria, in the Province of British Columbia, by the most feasible route to Dawson City, on the Yukon River, in the North West Territories. Apparently the total distance to be traversed by the telegraph is 1,400

miles, and we may fairly assume that more than ordinary difficulties will be met in constructing this line.

The ordinary share capital is not offered for subscription, so that the working capital is practically the debenture issue. If names of prominent political men are of value in such a concern, then we must confess that the board is an uncommonly strong one, for it includes a Canadian ex-premier, a Columbia ex-postmaster-general, and the mayor of Banbury. It is a notable fact that the resident engineer who will be responsible for the work is a late State mining engineer of the Transvaal, but it is doubtful how far experience in mining will be useful in laying out a telegraph system. A cheerful spirit of optimism pervades the whole of the prospectus, and it is especially exemplified in the estimate of profits. It is assumed that Dawson City will send off per diem 200 telegrams, averaging 10 words apiece and costing the sender £2 10s. No doubt a telegraph service will be much appreciated in Dawson City, but we cannot seriously entertain the idea that it has so developed as to require to send off 60,000 telegrams a year. Moreover, in the face of a tariff of 5s. per word, it is extremely unlikely that telegrams will average 10 words per message. Codes and cyphers will cover most communications in the English language, and we think after a year's work the directors will be inclined to accept the truth of this statement.

In our advertisement pages will be found a copy of the prospectus of Edmundsons' Electricity Corporation, inviting subscriptions for £75,000 4½ per cent. first mortgage debentures. The issue needs no commendation, for the excellent work upon which this Corporation is engaged is well known to our readers.

The Clayton Engineering and Electrical Construction Company, Limited.

This company has been formed with a share capital of £40,000, divided into 20,000 £1 preference shares and 20,000 £1 ordinary shares, and 400 debentures of £50 each. The company is to acquire the well-known works of the Clayton Foundry Company, Limited, at Clayton, near Manchester, where an apparently progressively profitable business has been conducted since 1888. The present issue consists of 15,000 ordinary shares, 15,000 preference shares, and 300 debentures.

West India and Panama Telegraph Company, Limited.

The ordinary general meeting of this company was held at Winchester House on Wednesday, Mr. William Andrews presiding. The chairman said the delay in holding the meeting was on account of warlike operations, and the irregularity of mails. The increase in the revenue was £1,400, but the accounts were not final. Reduction of tariffs and diversion of messages had resulted in discrepancies and inaccuracies. The first few months showed a loss consequent on the reduction of tariff they had to make, but subsequently this decrease was turned into an increase of revenue on account of the operations of the war. The receipts subject to correction still showed considerable augmentation, and after every allowance had been made on account of exchange and rebates, the result would be eminently satisfactory to the shareholders. They had been working under unexampled difficulties, and the company could take some credit that the lines had been kept going. It was particularly gratifying that the company should be enabled to work well at such an important international juncture when so much depended upon the celerity of communications. Referring to the present half year, the new cables had been substituted for the old ones connecting Granada and St. Lukes, and had greatly strengthened the company's duplicate system. Alluding to the disastrous visitation which the West Indies had suffered from, the company had voted 250 guineas towards the relief of the sufferers, and had also sent messages referring to the relief fund free, and this had contributed very much to facilitate relief. The chairman anticipated that they would be fairly treated by the American Government. After some discussion the accounts were adopted.

The Direct West India Cable Company, Limited.

The ordinary meeting of this company was held at the offices of the company, when the following report was submitted:—

"The company's cables were successfully completed and opened to the public on January 31st last. The Jamaica Government have passed a law granting to the company a subsidy of £2,000 a year for five years, and the Turk's Island Government have agreed to give £120 per annum for a similar period. The revenue account shows a credit balance of £15,045 8s. 7d., of which £10,490 12s. 10d. has been applied to the discharge of all expenses incurred prior to the opening of the cable for traffic, including the discount at which the debentures were issued (£6,000), leaving available £4,554 15s. 9d. It is proposed to pay a dividend for the half-year to June 30th at the rate of 5 per cent. per annum, which will absorb £750, leaving £3,804 15s. 9d. to be carried forward. A Stock Exchange quotation has been obtained for the debentures. Mr. Geo. G. Ward and Mr. Fred. Ward have been elected to seats at the board of the company."

After the chairman's remarks the report and accounts were adopted unanimously.

The Halifax and Bermudas Cable Company, Limited.

The annual general meeting of this company was held at the offices of the company on Wednesday last, when the following report was submitted:—"The delay in presenting the accounts is due to the pressure arising from the accession of business during the Spanish-American war. Since the last report the company contracted with the British Treasury to lay a cable to connect Bermuda with Jamaica, *viâ* Turk's Islands, and the Direct West India Cable Company, Limited, was formed to undertake the work. The contract was signed on August 2nd, 1897, and the cable was opened for traffic on January 31st, 1898. The extension greatly improves the position of your company by giving it through traffic. The receipts in the past year were £10,154 7s. 4d., as compared with £3,742 8s. 4d. in 1896-7. This increase is due to the opening of the Jamaica cable, and to the interruptions of other routes during the Spanish-American war. The net result is a profit of £6,655 0s. 8d., as compared with £951 15s. 11d., an increase of £5,703 4s. 9d. It is proposed to make a distribution of profits for the year by declaring a dividend of 5 per cent., amounting to £2,500. leaving £4,155 0s. 8d. to be carried forward. Offers for the sale of debentures to the trustees were invited in December and June last, and £4,989 7s. 6d. was paid for £5,100 of debentures, which amount has been written off capital expenditure. A Stock Exchange quotation has been obtained for the debentures." After the chairman had referred to the principal features of the accounts, the report was unanimously adopted.

Sheffield Electric Light and Power Company, Limited.—An extraordinary general meeting of the shareholders of the above company has been called, to take the first steps towards the winding up of the company before the completion of the purchase by the Corporation. The sale of the undertaking to the Corporation has now been confirmed by Act of Parliament, and the company expect that the purchase will be completed very shortly on the basis of the Corporation paying £218 for every £100 of capital properly expended by the company. The dividend authorised by the agreement between the company and the Corporation is at the rate of 10 per cent. for the year, and a resolution will be submitted declaring that dividend for the year ending December 31st. A special resolution will be submitted at the same meeting for the voluntary winding up of the company.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to:—Folkestone Electric Supply Company, Limited—10,000 ordinary shares of £5 each; and to allow the following securities to be quoted in the Official List:—British Aluminium Company, Limited—15,000 7 per cent. cumulative preference shares of £10 each, fully paid; London Electric Supply Corporation, Limited—£100,000 4 per cent. first mortgage debenture stock.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending December 10th, 1898, were £137 2s. 1d.; aggregate to date, £13,987 3s. 11d.

The Bradford City Tramways.—Week ending December 11th, 1898, miles of track open, road mileage, 4·72; car miles run, 5,828; number of cars, 16. Receipts, £247 3s.; total receipts to date, £4,682 4s.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending December 9th, 1898, were £2,558 8s. 10d.; corresponding period, 1897, £2,256 6s. 1d.; increase, £302 2s. 9d.

The City and South London Railway Company.—The receipts for the week ending December 11th, 1898, were £1,117; week ending December 12th, 1897, £1,101; increase, £16; total receipts for half-year, 1898, £23,754; corresponding period, 1897, £22,982; increase, £772. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending December 10th, 1898, were £142 9s. 5d.; week ending December 11th, 1897, £81 15s. 8d.; increase, £60 13s. 9d.; total receipts to date, 1898, £8,069 11s. 7d. Miles of track open week ending December 10th, 1898, 3; week ending December 11th, 1897, 3. Car miles run week ending December 10th, 1898, 4,181; week ending December 11th, 1897, 1,894. Number of cars week ending December 10th, 1898, 11; week ending December 11th, 1897, 5.

The Dublin United Tramways Company.—The receipts for the week ending Friday, December 9th, 1898, were as follows:—D. U. T. Co., horse cars, £2,180 15s. 6d.; ditto, electric cars, £560; D. S. D. Co., electric cars, £652 13s. 3d.; total, £3,393 8s. 9d; corresponding week last year—D. U. T. Co., horse cars, £2 568 16s. 11d.; ditto, electric cars, £108 9s. 7d.; D. S. D. Co., electric cars, £387 6s. 8d.; total, £3,064 13s. 2d.; increase, £328 15s. 7d.; aggregate to date, £91,943 3s. 7d.; aggregate to date last year, £85,210 18s. 5d.; increase to date, £6,732 10s. 2d. Worked:—The mileage open is 16 miles electrically, 28 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways. — The receipts for the week ending December 7th, 1898, were £236; total receipts to date, 1898, from June 29th, 1898, £6,067. Miles of track open, 3¾. Car miles run, 4,084 Number of cars, 10.

The Liverpool Overhead Railway Company.—The receipts for the week ending December 11th, 1898, amounted to £1,383; corresponding week last year, £1,296; increase, £87.

The South Staffordshire Tramways Company.—The receipts for the week ending December 9th, 1898, were £599 17s. 4d.; week ending December 10th, 1897, £550 9s. 3d.; aggregate receipts for 49 weeks, £30,949 18s. 8d.; last year, £30,976 1s. 4d.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending December 9th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,973.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Dec. 7th.	Closing Quotation, Dec. 14th.	Business done during week ended Dec. 14th, 1898. Highest.	Lowest.
127,400*l*	African Direct Telegraph, 4 % Debs.	100	4 %	...	...	101 —105	101 —105	101	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	92 — 95	92 — 95	...	...
905,560*l*	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	64 — 67	64 — 67	64¼	...
3,047,220*l*	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	114½—115½	115 —116	115⅝	114¾
3,047,220*l*	Do. do. Deferred...	Stock	...	...	...	16½— 16¾	16½— 17	16 13/16	16½
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15½— 15¾	15½— 15¾	15 9/16	15¼
75,000*l*	Do. do. 5 % Debs. 2nd series, 1906 ...	100	5 %	...	...	111 —115	111 —115	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	4 %	2¾— 3¼	2¾— 3¼	...	...
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	180 —190	180 —190	...	...
918,297*l*	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	105½	105¼
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½ %	2 %	...	1/16— 3/16	1/16— 1/16	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	10 — 11 xd	10 — 11	10¼	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	16½— 17½xd	16½— 17½	...	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	4½ %	105 —108%	105 —108%	...	...
60,710*l*	Direct United States Cable	20	2½ %	2½ %	...	11½— 12	11½— 12	11¾	11⅝
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	103 —106	103 —106	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	...	...	...	172 —177	172 —177	176	173½
1,295,000	Do. 3½ % Pref. Stock	100	...	...	...	104 —107	104 —107	105¾	104
500,000	Do. Prov. Certs., 50 % paid	...	...	...	...	54 — 57	54 — 57	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	5 %	101 —104	101 —104	...	...
1,432,268*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	124 —128	124 —128	125	124
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	17½— 17¾	17½— 17¾	17¾	17 2/16
16,200*l*	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	101 —105	101 —105	...	...
64,400*l*	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	102 —105	102 —105	102⅝	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	125 —129	125 —129	126	...
35,100*l*	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	101 —105	101 —105	...	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	102 —105	102 —105	...	...
300,000*l*	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	103 —106	103 —106	102⅝	...
200,000*l*	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	103 —106%	103 —106%	103¼	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	4½ %	12¼— 12⅝	12¼— 12⅝	12⅝	12¼
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16½— 17	16¾— 17¼	17	16⅝
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	10 %	28½— 29½	28½— 29½	...	...
150,000*l*	Do. do. do. do. 5 % Debs. ...	100	5 %	5 %	5 %	100 —103	100 —103	...	...
97,800	Halifax & Bermuda Cable, 4½ % 1st. Mt. Dbs., w'n. 1-1,200, rd.	100	...	...	...	101 —104	101 —104	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	54 — 57	54 —57	...	...
100,000*l*	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	6 %	109 —112	109 —112	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	5½ %	6 %	5½— 5¾	5½— 5¾	5¾	5⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	13⅜	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5¼— 5½	5¼— 5½	5 7/16	...
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	100—103	100 —103	102½	102
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	⅝	...
100,000*l*	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	134 —139	134 —139	139	...
58,000	United River Plate Telephone	5	4 %	5 %	6 %	4¼— 4¾	4¼— 4¾	4¾	...
151,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	104 —107	104 —107	106¼	...
200,000*l*	West African Telegraph, 5 % Debs.	100	5 %	5 %	5 %	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	103 —106	...	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3¼ %	12¼— 12⅜xd	12¼— 12⅜	...	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	8 — 8¼xd	8 — 8½	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	½ %	4 — 4¼xd	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	107 —110	107 —110	107	...
88,321	West India and Panama Telegraph	10	7½ %	1 %	2½ %	1⅛— 1⅜	1⅛— 1⅛	1⅜	1 5/16
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	6 %	9½— 10	9¾— 10¼	10⅛	9¾
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	6 %	7 — 9	7 — 9	...	...
80,000*l*	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	106 —109	106 —109	...	...
158,100*l*	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	6 %	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	11½— 12½	11½— 12½	...	...
20,000	Do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6¾	6 — 6¾	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	5 %	6 %	8 — 9	8½— 9½	8⅞	...
60,000	Do. do. do. 4½ % Deb. Stock Red....	Stock	4½ %	4½ %	4½ %	114 —116	115 —117	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000 ...	10	5 %	7 %	10 %	24½— 25½	24 — 25	25	24½
10,000	Do. Ord. Nos. 90,001 to 100,000	10	...	...	...	24 — 25	23½— 24½	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½— 16¼	15½— 16½	16¼	16
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	127 — 132	127 —132	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	*nil*	*nil*	*nil*	12½— 13½	12½— 13½	...	...
10,000	Do. do. do. Nos. 30,001 to 40,000 £8 paid.	10	...	...	...	10 — 11	10 — 11	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14½— 15½	14½— 15½	...	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	...	5 %	5 — 5½	5 — 5½	5¼	...
15,661	House-to-House Electric Light Supply, Ord., 101 to 15,761	5	...	...	4 %	9 9/16— 9 7/16	9 — 10	9 7/16	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	9½— 10½	9½— 10½	9⅝	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3½— 4	3½— 3⅞	...	...
48,050	Do. do. do. 6 % Pref.	5	...	...	...	6 — 6½	6 — 6 7/16	...	...
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	17 — 18	17½— 18½	17⅝	16¾
220,000*l*	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	4½ %	117 —121	117 —121	...	...
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	16 — 17	16½— 17½	17	16¾
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7½ %	10½ %	14½ %	17 — 18	16 — 17	17⅜	16½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	9⅜	9½
50,000	Do. do. 4 % Deb. Stock Red. ...	Stock	...	...	4 %	105 —108	105 —108	...	...
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	2⅞— 3⅛	2⅞— 3⅛	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	16 — 17	16 — 17	16¾	15 7/16

* Subject to Founder's Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation Dec. 7th.	Closing Quotation Dec. 14th.	Business done during week ended Dec. 14th, 1898. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	3¼— 3⅜	3½— 3⅜	3⅜	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	94 —100	94 —100	...	...
30,000	British Electric Traction	10	...	...	...	16 — 17	16 — 17	...	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	12½— 13½	13 — 13½	13⅝	13 1/16
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½ %	*nil*	*nil*	1¾— 2	1¾— 2	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2⅛— 2⅜	2⅛— 2⅜	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	111 —115	111 —115	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	103	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	9½— 10½	9½— 10½	...	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	111 —114	111 —114	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9⅜— 10¼	9⅜— 10¼	10	...
178,303	Do. do. do. £6 paid	10	...	...	...	5⅜— 6⅛	5⅜— 6⅛	6	5⅝
61,033	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1¼— 1⅜	1¼— 1⅜	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼— 4⅜	4¼— 4⅜	...	...
630,000*l*	City and South London Railway	Stock	1 3/16 %	1 1/16 %	1⅛ %	65 — 68	65 — 68	66¼	...
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £4 pd.	10	...	...	...	3½— 4	3½— 4	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	1½— 2	1¾— 2¼	...	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	91 — 96	91 — 96	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½ %	6 %	2 —	2 — 2½	2 7/16	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5½ %	6 %	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	99 —101	99 —101	...	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	6 %	2¼— 2½	2¼— 2½	2 7/16	2 5/16
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	2¾— 3¼	2¾— 3¼	...	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	105 —107	105 —107	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	¼— ⅜	¼— ⅜	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	¼— ½	¼— ½	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½ %	7 %	7 %	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	10 %	12 %	20 — 21	20½— 21½	21¼	21⅛
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18 — 19	18 — 19	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	4½ %	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21½— 22½	21½— 22½	22⅛	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅝ %	2⅝ %	3⅛ %	10 1/16— 10 3/16	10 1/16— 10 3/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15 — 15½	14¾— 15½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	37 — 41	37 — 41	38½	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	113 —116	112 —115	113¼	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10—12; 7 % Pref., 11—13.
House-to-House, 4½% Debentures of £100, 106—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 13—13⅛; 1st Preference Cumulative 6%, £5 (fully paid), 7⅞—8¼. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, ⅜ to ½.
Smithfield Market Electric, 2—4.
*T. Parker, £10 (fully paid), 15—16.
Yorkshire House-to-House Electricity, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6%.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (October 13th, 1898).

MARKET QUOTATIONS, Wednesday, December 14th.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per ton	37/-	37/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a „ „ (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. per ton	£16 10	£16	10/- inc.
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a „ (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£19 10	£19 10	..
a Lead, Nitrate .. .. .. per ton	£23 10	£23 10	..
a „ White Sugar .. .. per ton	£30 10	£30 10	..
a „ Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3½d.	3¼d.	¼d. dec.
a „ Caustic (75/80 %) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	65/-	65/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a „ Recovered .. .. per ton	£5 15	£5 15	..
a „ Lump .. .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a „ Crystals .. .. .. per ton	£3	£3	..
a „ Bichromate, casks .. per lb.	3d.	2¾d.	¼d. inc.

METALS, &c.	This week.	Last week.	Increase or Decrease.
b Aluminium Wire, in ton lots .. per ton	£224	£234	..
b „ Sheet, in ton lots.. per ton	£191	£191	..
c Brass (rolled metal 2" to 12") basis per lb.	6¾d.	6¾d.	..
c „ Tube (brazed) .. .. per lb.	8¼d.	8¼d.	..
c „ Wire, basis .. .. per lb.	7d.	7d.	..
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f „ Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£66	£66	..
g „ Wire (basis price) .. per lb.	8d.	8d.	..
g „ Sheet .. .. .. per ton	£66	£66	..
g „ Rod .. .. .. per ton	£66	£66	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	5/6	6d. inc.
h India-rubber, Para fine .. .. per lb.	3/11½ forw'd	3/10½ for'd	1d. inc.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) per ton	44/6	50/-	5/6 dec.
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. .. per ton	45/-	45/-	..
i „ Wire galvanised No. 8 .. per ton	£8 15	£8 15	..
g Lead, English Ingot .. .. per ton	£13 5	£13 7 6	2/6 dec.
g „ „ Sheet .. .. per ton	£14 5	£14 10	5/- dec.
l Mica (uncut slabs 8" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£7 15	£7 15	..
o Platinum .. .. per oz.	£3 1 6	£3 1 6	..
i Steel, Magnet, according to description .. .. .. per ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£85 10	£86	10/- dec.
g „ foil .. .. per lb.	1/3	1/3	..
n „ wire Nos. 1 to 16 .. .. per lb.	1/4	1/4	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	6¼d.	6¼d.	..
„ Flax, 6 or 8 lea... .. per lb.	3½d.	3½d.	..
j „ Hemp, 3 ply 10 lbs. .. per lb.	3½d.	3½d.	..
j „ „ Russian, 10 lbs. per lb.	4½d.	4½d.	..
j „ Jute, 180 lbs. rove .. per ton	£12	£12	..
j „ Manila, 24 thread .. per ton	£29	£29	..
k Zinc, Sheet (Vielle Montagne bnd.) p. t.	£29 10	£29 10	..

a Quotations supplied by Messrs. G. Boor & Co.
b „ „ „ The British Aluminium Co., Ltd
c „ „ „ Messrs. Thos. Bolton & Sons.
d „ „ „
e „ „ „
f „ „ „ The India-Rubber, G.-P., and Teleg. Works Co Ltd
g „ „ „ Messrs. James & Shakspeare.
h „ „ „ „ Jackson & Till.
i Quotations supplied by Messrs. Bolling & Lowe.
j „ „ „ „ Henry C. Yeo & Co.
k „ „ „ „ Morris Ashby, Limited.
l „ „ „ „ Sanders, Wake & Co.
m „ „ „ „ W. T. Glover & Co., Ltd.
n „ „ „ „ P. Ormiston & Sons.
o „ „ „ „ Johnson, Matthey & Co., Ltd

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRISTOL, 1898.

EXPERIMENTS ON THE INFLUENCE OF ELECTRICITY ON GROWING VEGETABLES OR PLANTS.

By Selim Lemström,
Professor of Physics at the University of Helsingfors.

Read before Section A.

(*Concluded from page* 842.)

The experiments began about June 18th, and have been continued till September 11th. Both fields were equally watered. Before our departure from Helsingfors two photographs were taken of the tobacco plants, two from the field of experiment, and two corresponding from the fields of control.

A corresponding pair of these photographs is represented in the illustrations on the next page.

It is not too much to estimate the increase of the plants on the experimental field to 40 per cent. The photographs were taken the first days of July, and the electrical machine had been working only 164 hours. We can consequently conclude that all plants, without one exception, will be activated by the electricity applied in the way as we have done it, pre-supposed that they are watered enough, or that not too much electricity is given, and especially not together with rays from a burning sun.

When the experiments are carefully considered, the following law seems to result with high probability.

The more fertile the soil and the more vigorous the vegetation, the more will the effect of the electrical current increase.

Number of results from the Table V. show that. We will compare two experiments on potatoes and red beets; the one made on the field of the Garden Society, the other on the field in B ödtorp. The former field possessed all the properties of a garden soil, the latter was a little better than an ordinary field for farming.

	Garden soil.	Field.
For the potatoes an increase of	76·2 per cent.	24·3 per cent.
„ red beets „	65·3 „	31·7 „

The electricity will in a high degree accelerate the ripening of fruits, berries, and roots, and probably develop more sugar in them. The former part of this result is well stated through experiments on strawberries and raspberries—the latter will be object for further investigation. In the greenhouse the strawberries under electrical current ripened in an average time of 30 days, when 24 days more, or in all, 54 days, necessary for the berries without the benefit of the current. The same is the case with raspberries on the open field in Brödtorp, though the difference of time was there only 17 days. The development of sugar is stated by an analysis made in France on white beets, giving an increase of about 15 per cent of sugar, to which the remarkable augmentation of the sweetness of the strawberries, in the same place, will contribute.

Comparing the experiments made in south of Finland and in Bourgoyne, we find the results in general to be the same, but the increase seems to be less in Bourgoyne. We must, however, remember that the weather during the summer, 1888, in Bourgoyne was exceptionally bad, and considering the law of greater development in the more vigorous vegetation, we cannot pretend that this fact is sufficiently proved.

The general conclusion of the above-stated results will be:—

The electricity given to the air through points in connection with the one pole of an electrical machine, the other being conducted to the earth, exercises under all circumstances a great effect on growing vegetables.

The effect will be greatly favourable to the development of the vegetables only when the supply of water is, within certain limits, barely sufficient.

This will be the case, for the most part, of vegetables under ordinary circumstances, assuming that the electricity is given during three to four hours in the morning, and three to four hours in the

Table V.—Review of all Results.

Species of plants.	Year.	Place.	Experimental field. Reaped area m².	No. of plants.	Weight of res. kg. ma.	Weight of res. kg. 2 a.	Control field. Reaped area m²	No. of Plants.	Weight of res. kg. 1 ma.	Weight of res. kg. 2 a.	Increase per cent.	Remarks.
Wheat ...	1886	Brödtorp*	5,101	...	198	1,028	5,101	...	126	1,166	57·9	This is the increase of the 1 ma. quality.
„ ...	1887	„	2,235	...	...	648	2,896	...	...	971	51·4	
„ ...	„	„	1,931	...	...	645	244	...	...	„	39·5	The increase is calculated after m².
„ ...	1888	Bourgoyne	450	...	...	77·6	450	...	...	64·0	21·2	
Rye ...	1887	Brödtorp*	15,000	...	...	2,720	5,000	...	...	975	3·7	The ears were quite developed when the
„ ...	„	„	5,000	...	...	920	„	...	...	„	15·7	experiment began.
Barley ...	1885	Vichtis*	110·8	...	...	11·1	149·1	...	...	10·92	64·1	The area of the control field is the aver-
„ ...	1887	Brödtorp	155	...	...	27·2	765·5	...	...	72·7	84·9	age area of 2 B + C + (D + E), and
„ ...	„	„	280	...	...	38·5	„	...	...	„	44·9	also the weight in kg.
Oats ...	„	„	329	...	...	29·1	329	...	...	18·9	53·9	
„ ...	1888	Bourgoyne	450	...	...	142·6	450	...	..	120·2	18·6	
White beets	1886	Garden of Soc. Hort.*	...	56	...	32·0	...	157	...	43·3	107·2	
„ ...	1888	Bourgoyne	75	335	...	359·0	75	245	...	361·0	−27·2	The negative result caused probably by want of water. Increase of sugar 18%.
Red beets	1886	Garden of Soc. Hort	...	107	...	24·6	...	263	...	36·6	65·3	
„ ...	1887	Brödtorp	49	625	...	31·5	49	340	...	13·0	31·7	
„ ...	1888	Bourgoyne	...	289	...	567·0	...	309	...	5·21	16·4	
Potatoes ...	1886	Garden of Soc. Hort.†	...	268	...	21·3	...	990	...	44·7	76·2	
„ ...	1887	Brödtorp	329	1,751	...	529·1	329	1,905	...	463·3	24·3	
Carrots ...	1888	Bourgoyne	...	...	...	29·0	...	...	...	13·0	123·0	The carrots have before given negative result, but watered they gave this high per cent. increase.
Radish ...	1886	Garden of Soc. Hort.	...	26	...	2·3	...	57	...	3·2	59·1	
Parsnips ...	„	„	...	181	...	16·2	...	5·07	...	29·1	54·0	
Onions ...	„	„	...	51	...	7·7	...	98	...	10·4	42·1	
Celery ...	„	„	...	45	...	22·2	...	98	...	35·7	36·9	
Beans ...	1887	Brödtorp	49	412	...	9·0	49	413	...	5·1	76·6	
„ ...	1888	Bourgoyne	...	...	...	3·0	...	...	...	2·0	36·4	
Peas ...	1887	Brödtorp	49	436	...	2·98	49	445	...	5·7	47·1	The peas gave negative result in Brödtorp, but watered they gave a high per cent. increase.
„ ...	1888	Bourgoyne	...	...	...	...	...	...	...	...	75·0	
Garden Strawberries	1886	Greenhouse of Soc. Hort.	...	...	...	...	...	...	...	...	...	The time for ripening shortened from 54 days to about 30 days.
„ ...	1888	Bourgoyne	...	...	...	...	...	...	...	...	...	Gave by want of water a negative result, but watered they should have given from 70 to 80 per cent. increase.
Raspberries	1887	Brödtorp	49	47	...	0·51	49	46	...	0·26	95·0	From the first gathering } About 51
„ ...	„	„	„	„	...	0·23	...	„	...	0·23	−2·1	„ second „ } per cent.
„ ...	1888	Bourgoyne	...	...	...	3·28	...	...	...	2·30	43·0	(Planted the same year.)
Tobacco ...	1887	Brödtorp	49	108	...	67·5	49	108	...	77·8	15·3	The tobacco gave, leaves and branches
„ ...	1898	Helsingfors	...	...	...	...	...	...	...	...	40·0	together, a negative result, but watered, a positive about 40 per cent.

* Brödtorp, Vichtis, and the gardens near Helsingfors are all situated in south of Finland.
† Cabbage and part of roots have given negative results, but as that depends of want of water, they are not taken up here.

afternoon, avoiding the hours of the highest sun, when the sky is clear.

When the supply of water is abundant, the electricity can be given during the whole 24 hours with a favourable result.

The surest way to produce a favourable effect seems to be *to limit the giving of the electricity to a moderate time*, so that the vegetative process is not forced too fast.

The Causes of the Effect of the Electricity.

The above stated facts show that we are facing here a phenomenon of a somewhat astonishing character. With a very little work, transformed to electricity, we are able to exercise a great encroachment in the life of the vegetables and to increase their return value to about a half more than before. As it seems to be indifferent in what direction the current is going, we cannot look for the cause in these properties of the current, which simply depend on its strength. We know that the current develops heat, independent of its direction, and here could be a possibility of the explanation, were not the intensity of it so little. We cannot ascribe the effect to this trifling heat, which could not raise the temperature of the plant $\frac{1}{1000}$th part of a degree.

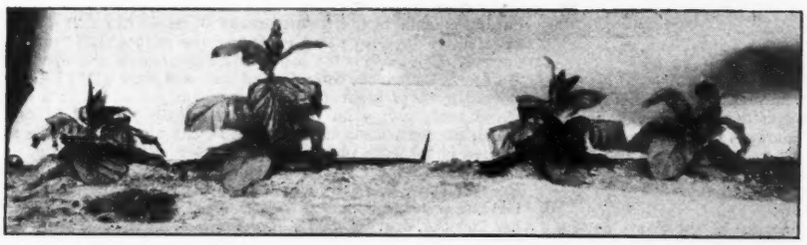


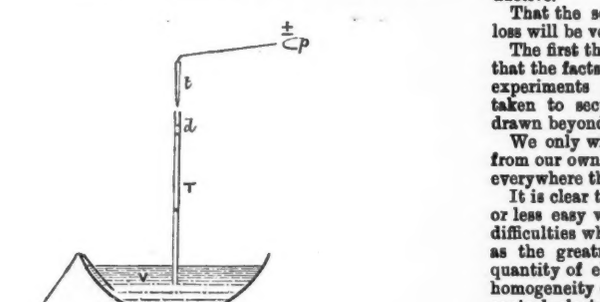
Fig. 3.—Experimental Field.

The electricity, forced to stream out from points, will transform the air in such compounds, for instance, ozone and nitrogen oxides, which should contribute to the feeding of the plants, and then it would be right what a friend of mine said, when he heard of the results of this experiment, viz, that a new manure had been discovered. Considering the effects of thunder in nature, the mentioned view is not totally without foundation. We can certainly ascribe to it an effect, but it cannot be the single cause. When it should be the case, an augmentation of the number of points on the wires must have the consequence of increasing effect. The experiments on corn, 1897, seem to show that the effect is nearly independent of the number of points. The justness of the conclusion is therefore doubtful, but it must be conceded that further confirmation of it is wanted.

Fig. 4.—Control Field.

During some experiments with which a younger explorer, Dr. Wiklund, was occupied, he made in a letter the remark that the cause could be sought for in a change of the capillary forces within the plants. We could not agree with that opinion for several reasons, the principal being the smallness of the E.M.F., which might perhaps be the effect of the electricity given to the air from the points. Some experiments, made shortly before my departure from Finland, have revealed another cause, which seems to be new, at least, in the way these experiments were performed.*

Two capillary tubes, of respectively about 0·5 mm. and 0·1 mm. diameter put in two different small vessels of water, were connected, through tinfoil and wire with the gas tubes in the room. The capillary tubes, see fig. 5, were held upright and the distance from the upper end of the water thread in the tube to the end of the glass tube was about 4 cm. If a point, connected with the positive pole of a Holtz machine (with 4 plates), was placed exactly on the end of the glass tube, the machine being working with its negative pole conducted to the earth, the water began to climb up the inner walls of the tube and appeared in its upper end after about half a minute as a water-drop, or rather a short water-cylinder. The effect seemed to be equal in the both tubes, and the same effect appeared when the point was connected with the negative pole of the machine, the positive with the earth. At first we could not assume that this phenomenon had anything to do with our experiments on the plants; for against such a conclusion was the high potential which was needed before the water began to climb up the walls. A nearer scrutiny of it shows, however, that just the contrary must be the case. A plant consists of merely very thin capillary tubes, and when they are surrounded by the electrified air, in which the potential can attain a high value, the effect must be that the juices in the plants begin to climb up along the walls of these tubes. As that phenomenon is just one of the principal facts in the vegetation, it must be made much more pronounced by the surrounding electrified air, because the distance between the capillary tubes and the electrified air is here infinitely small.



V is a vessel with water conducted to the earth; T a capillary tube; *t* a point in connection with the + or − pole of an influence machine, the other pole being conducted to the earth.

Fig. 5.

We are now standing here before new facts, the conclusion of which must be that the electricity in the air plays a far greater *rôle* in the vegetative process than hitherto has been assumed; but even here further experiments are necessary, and it will be our next work to accomplish an investigation of these phenomens.

In connection with the above stated results, the following question will only be a natural consequence:—

Is this discovery of the great influence of electricity on vegetables of practical consequence, that is to say, can the method be applied to agriculture or horticulture?

A thorough discussion of this question must be left to another occasion, but at present it will be enough to state, when an agriculturist or a gardener has made all possible efforts to cultivate, manure, and water his soil, he can still, by applying the electrical treatment, increase its returns to about 40 per cent.

As the method is now very easy to apply, and the costs for an area of 20 hectares will be about £15 to £20 preliminary expenses, of which only 10 per cent. can be taken as a yearly expense, the daily cost for the working being very little; the answer to the question must be that a practical application of the electricity will be highly productive.

In fact, the agriculturist, in applying the electrical treatment, will only make his soil more productive every year and hasten the ripening of his harvest, and in this way make his capital more productive.

That the soil must yield more of its fertility is natural, but the loss will be very little compared with the great benefits.

The first thing is for everyone to convince himself by experiments that the facts here stated are real. This will be best attained by experiments under scientific control, in which all possible care is taken to secure good results, and from which conclusions can be drawn beyond all doubts.

We only wish that by these experiments all the deductions drawn from our own experiments should be carefully considered and applied everywhere they can be of use.

It is clear that the practical application depends also on the more or less easy way in which this application can be made. All the difficulties which appear at a scientific research for stating of facts, as the greatness of increase under different circumstances, the quantity of electricity to be given to a field of a certain area, the homogeneity of the soil in the fields of experiments and the field of control, electricity does not exist at the practical application. The question is only to be sure that the wire net is charged. This again requires that the wire net is insulated and that the machine is always working. The former is easy to attain, the latter has hitherto been more difficult. The influence machines of different kinds have only been used in laboratory work, and also by medical men, but not for more prolongated work, and seldom without sparks or other discharges between the poles. An application of the machine for producing electricity to charge a wire net in the open field, during an interval of several hours, requires a machine working steadily and continually with open poles, viz, without sparks and other discharges between them.

Among the machines hitherto used, those of Holtz, and especially

* It can have a relation to some experiments of Gernez.

of Wimshurst, slightly modified, have been the best, but also this latter has often ceased to work in an air charged with humidity.

Guided by a long experience we have constructed a new machine, which will meet all the requirements of experiments of every kind, also those at which the machine is working with open poles.

The method applied at our experiments is only an imitation of what is performed by the greatest of all teachers, namely, Nature itself; but a more profound knowledge of the phenomena will probably conduce to more perfect methods.

An installation of a central station, from which electricity can be conducted by insulated wires, several miles to the surrounding fields, will probably in the future be the most practical way to apply the electricity on vegetables.

It is our aim to afford the making of experiments in different places in Europe and in America, and we venture to hope that they will also be executed in England, from which country rich experience is always spreading over the whole world.

Elaborate rules for the application of the method in all details will be given separately.

INSTITUTION OF ELECTRICAL ENGINEERS.

"Rotatory Converters." By Prof. Silvanus P. Thompson, D.Sc., F.R.S., Vice-President. (Paper read November 10th, 1898.)

(*Concluded from page* 883.)

Quite recently Mr. Gisbert Kapp* has re-examined the question of the influence on the conversion ratio, and on the efficiency of changes in the distribution of the flux. With the theoretical case of a sine law distribution he compares analytically other cases, equally unreal in fact, namely, those of a distribution of supposed uniform density over a limited arc of polar span. From his calculations it may be deduced that the conversion ratio will be the same as for the sine-law distribution if the poles are such that the breadth of their faces is about 70 per cent. of the pole pitch. If the faces are broader, the voltage ratio for a single-phase machine will be lower than 70·7 per cent., and the ampere ratio higher than 141·4 per cent. If the pole breadth is reduced to two-thirds of the pole-pitch, or to

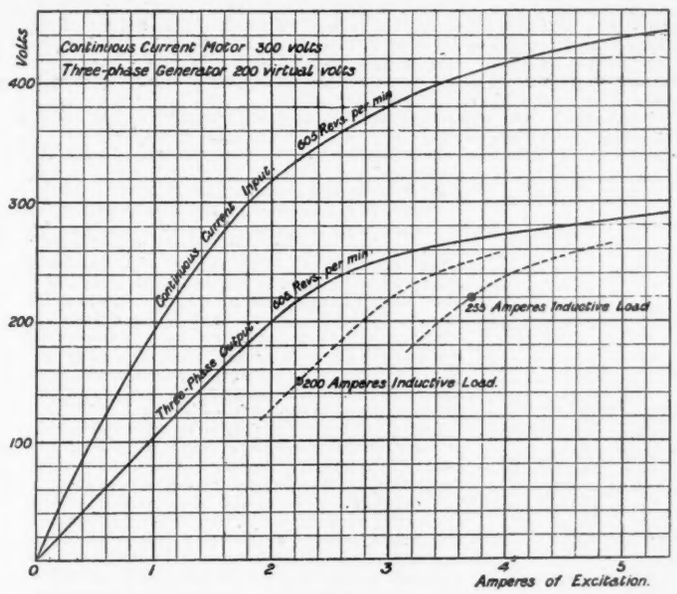


Fig. 13.

⅓ the pole-pitch, the respective voltage percentages become as follows:—

Voltage for	Sine law.	Pole ratio, ⅔.	Pole ratio, ½.
Continuous current ...	100	100	100
Single-phase	70·7	75	82
Two-phase	70·7	75	82
Three-phase	61·2	65	71
Four-phase...	50·0	53	58
Six-phase	35·35	37	42

* *Elektrotechnische Zeitschrift*, Vol. xix, p. 621, September 15th, and following numbers of September 22nd and 29th, 1898.

M. Routin* has made another study of the effect of varying the pole breadth, in a mathematical paper, in which also he assumes the uniformity of the field beneath the poles.

In the Oerlikon converter above described the pole breadth was only 55 per cent. of the pitch, yet the voltage ratio was 66·6, showing that the field does not distribute itself uniformly, but is less concentrated, with fringing at the pole-tips.

Mr. Kapp has further treated the question of the limit of output for equal heating, for different pole breadths, and for different angles of phase, displacement in the currents. When the phase displacement is zero the limiting output of a single-phase converter armature was (see above) 85 per cent. of that when used as a continuous current armature simply, if the sine law is assumed. For pole breadths of ⅔ and ½ respectively Kapp finds this increased to 88 and 95 per cent. This is equivalent to saying that if by concentration of field one makes the midway coils relatively more active, there will be for equal output less heating of the coils next to the connectors, and a less total heating. If there is a phase displacement such that $\cos \phi = 0.8$ ($\phi = 35°$), the percentage output for sine law distribution is 69, but with pole breadths ⅔ and ½ respectively this is raised to 73 and 80 per cent. But in practice the fringing of the field will reduce these latter values. For the more favourable cases of two-phase and three-phase converters, these percentages of output for equal heating of the armature are greatly raised. The three-phase converter, assuming sine distribution and no phase displacement, has a limiting output 134 per cent. of that of the simple continuous current armature. With pole breadths of ⅔ and ½, the output rises to 138 and 144 per cent. respectively, and if there is a phase dislocation such that $\cos \phi = 0.8$, to 117 and 126 respectively. For a two-phase converter the limiting output of 164 per cent., for the case of sine distribution and $\cos \phi = 1$, becomes 167 and 170 per cent. respectively for pole breadths of ⅔ and ½, whilst when $\cos \phi = 0.8$, these numbers fall to 144 and 153 per cent. respectively.

A four-pole 30-kilowatt two-phase converter, constructed by Messrs. Brown, Boveri & Co., has been described to me by Mr. M. B. Field, who designed it for that firm. The armature is wound according to the scheme shown in fig. 14. It has four poles (two wound, two unwound), and runs at 1,200 revolutions per minute, giving a frequency of 40 periods per second. Its efficiency is about 90 per cent. The input being two currents, of 415 working amperes each, in quadrature of 40 volts, the output is 500 amperes at 60 volts. The armature is a cylindrical drum-wound, in 56 slots, with two conductors per slot, as a singly re-entrant double winding, being cross connected at the slip rings to give four parallel circuits. At normal load, the excitation is such as to give a flux density in the armature core body of 7,800 lines per square centimetre, and in the teeth of 10,700 to 14,900. It runs (as exciter for some two-phase alternators) in parallel with some turbine-driven exciters and with a two-phase to continuous motor generator. The ratio of conversion, when running as two-phase motor, did not alter greatly with the excitation, as the following figures show:—

Exciting current.	Virtual volts between slip rings.	Volts at commutator.	Ratio of conversion percentage.
2	18·5	30·0	60·8
3	27·0	43·0	62·7
4	34·0	53·0	64·2
5	41·0	62·0	65·1
6	46·5	68·5	67·8
8	53·0	77·0	68·5
10	56·5	82·0	68·8
12	59·0	86·0	68·6
14	62·0	88·5	71·0

It is, however, in America that the converter has found its application on the largest scale, for the purpose of supplying continuous currents for tramway circuits, electric lighting systems, and electrolytic processes from distant power stations, whence the transmission is accomplished by polyphase currents at high voltage. These high voltage currents, when they reach the receiving end, are first passed through transformers to reduce the pressure to a suitable lower voltage, and are then passed through the converters. The first large converters of the General Electric Company were designed by Mr. Parshall on the lines of ordinary multipolar continuous current generators, with powerful field magnets, and performed their functions well. Later, some designs were tried with relatively weaker field magnets, on the assumption that, in view of the lesser amount of armature reaction, commutation might be effected sufficiently well in spite of a lighter construction. But though a three-phase converter will, without any winding on the field magnets, operate by virtue of the armature reactions peculiar to the synchronous motor, the regulation in such machines leaves much to be desired, and the later designs exhibit a return toward the construction usual for multipolar continuous current generators. By the kindness of Mr. Parshall and of Mr. Steinmetz, information as to a number of such large converters is available.

At Niagara, where the Cataract Company generates two-phase current at 5,000 volts, converters are employed to supply continuous current for certain electrolytic processes—for the manufacture of caustic soda and of aluminium. For the Pittsburgh Reduction Company's aluminium works the General Electric Company constructed a number of large converters. The two-phase current is first reduced

* *L'Eclairage Electrique*, Vol. xi., p. 531, June 12th, 1897.

by transformers to a pressure of 115 volts. At this pressure it is led into the converters, which give out the continuous current at 160 volts; the plant having a total capacity of over 10,000 amperes, equivalent to an output of about 2,000 H.P. At Schenectady were also constructed the six three-phase converters of 200 kilowatts each, for use in the power house at Brooklyn. As these machines are fairly

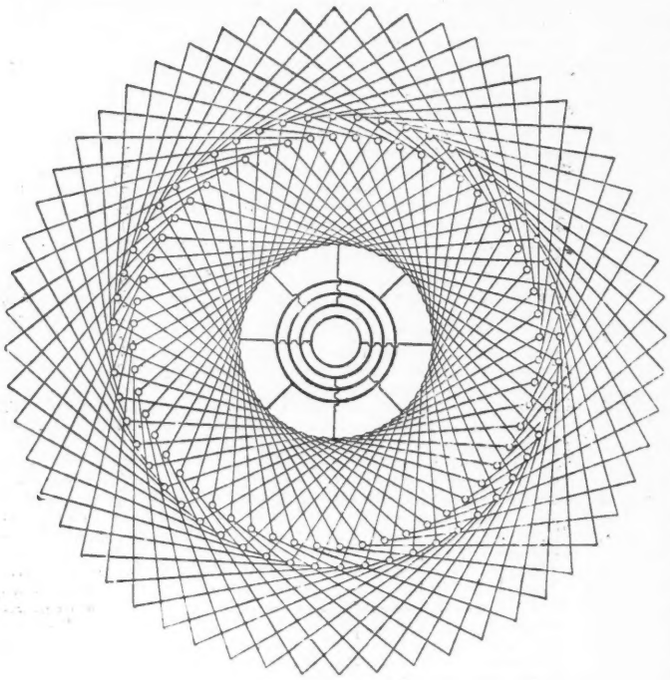


Fig. 14.

typical of American practice, some information of their general construction is of interest. They are eight-pole 200-kilowatt machines, running at 375 revolutions per minute, the frequency employed being 25. The voltage on the three-phase side is 82·8, that on the continuous current side 125, with an output of 1,600 amperes. The armature is 48 inches in diameter, its core length being 7 inches between heads. This gives 4·95 square inches of peripheral surface per kilowatt.* The core discs have 240 slots, with two conductors

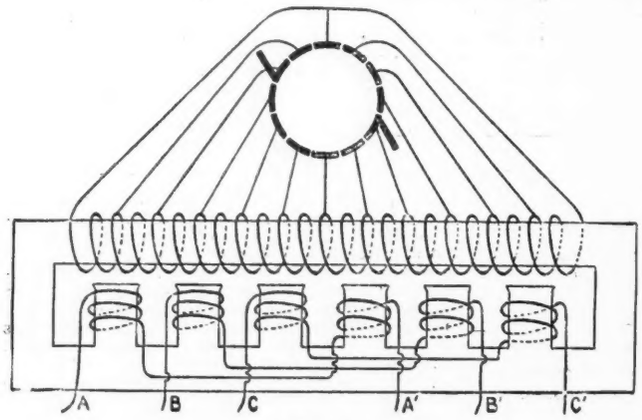


Fig. 16.

in each slot. Each lap of the drum winding is over 30 teeth. The gap measures 0·25 inch from iron to iron. The commutator is 36 inches in diameter, with 240 bars. The three slip rings are each 18 inches in diameter, 3½ inches broad, and 1 inch deep. The brushes are of carbon, eight sets of nine brushes each, and each brush with 1¼ square inches of contact surface. The brushes on the three-phase side are of copper. The flux through each pole face is designed to be 4,380,000 lines at full load, the flux density in the cast-steel pole cores being then 80,000 lines per square inch. In the gap the pole face density at full load is no less than 51,300 lines per square inch. In the teeth it reaches 135,600, and in the core body 61,300. When running as a converter the brushes have no lead. When running on test as a continuous current generator, a lead equal to four bars of the commutator was necessary. The pole breadth is 64·7 per cent. of the pole pitch, and the voltage ratio of conversion 63·3 per cent. The C^2R loss in the converter armature at full load is 3,500 watts; it would be 6,250 if used as a continuous current generator. The total armature loss as converter is 6,005 watts; as continuous current generator 9,130 watts. The temperature rise of the armature at full load is 27° C. as converter; as continuous current generator it is 47° C. The temperature rise of the commutator at full load is 36° C. as converter; as continuous current generator, 52°.

Another three-phase converter also constructed at the Schenectady works is a 16 pole 600-kilowatt machine, running at 188 revolutions per minute. In this machine the pole breadth is 72 per cent. of the pole pitch, yet the ratio of conversion is 71·8; the voltages at the respective sides being 115 and 160. The armature diameter is 100 inches, the core length 8·25 inches, giving 4·3 square inches of peripheral surface per kilowatt. The temperature rise after 17 hours, with a conversion output of 575 kilowatts, was 150° C. in the armature, 23° C. in the field magnets. The average flux density in the gap was 69,000 lines per square inch.

To the same class of machines belong the four three-phase converters recently designed by Mr. Parshall (fig. 15*) for the Central London Railway. These are 12-pole 900-kilowatt machines, running at 250 revolutions per minute. Each weighs about 30 tons, and their guaranteed efficiency will be 95 per cent. at full load, 93 per cent. at half load. They are designed to take in their three alternating currents of 1,800 virtual amperes, each at 310 virtual volts, the output on the continuous current side being at 550 volts. The armature in each is a multipolar drum with 432 slots, and two conductors per slot, and being lap-wound, has 24 circuits in parallel. It is connected down at 18 symmetrical points to the three slip rings, there being six such connectors to each ring. Owing to the conditions imposed by the relations between voltage, speed, and size, it has been the practice in the States to design converters to operate at a frequency of 25, or at most, 30 periods per second. But some of the General Electric Company's converters have been constructed for frequencies as high as 60, so as to be capable of being operated from lighting circuits. One such, a 16-pole 400-kilowatt two-phase converter, running at 450 revolutions per minute, has been recently described in the *Electrical World* (May, 1898).

One difficulty which has been experienced when operating converters in their application on the large scale—a difficulty which could hardly have been foreseen from the working of small isolated machines—is a tendency for them, when grouped in parallel, to set up a see-sawing interference of slow period, probably in consequence of armature reactions, similar to those which in certain types of alternators trouble their parallel running. Another puzzling defect is a similar tendency to hunt, observable when two converters are arranged in series at the two ends of a long three-phase line for the purpose of feeding continuous currents from one point to another. The cure for these troubles will probably be found in an analogous treatment to that adopted for securing good parallel running in alternators, namely, careful design, so as to prevent armature reactions from unduly distorting the magnetic field. But the point demands further investigation.

Before quitting the subject of converters, it is but right to refer to the existence of another class of rotating machine for effecting the same aim, and to which, for distinction, the name of *permutators* may be allotted. In this category are comprised those machines in which alternating currents (of one, two, or three phases) are first transmitted through a stationary part of the apparatus (a species of transformer), where they create in a re-entrant sectional winding a series of alternating currents which differ from one another in phase by small successive phase angles; these currents being then led off to a commutator and commuted, section by section, into a continuous current. To fix ideas, consider fig. 16, which is adapted from a recent article by Dr. J. Sahulka in the *Zeitschrift für Elektrotechnik*. The lower part of the diagram represents the stationary transforming apparatus having three pairs of projecting poles, wound with three circuits, A A′, B B′, and C C′, to which are brought the three-phase primary currents. The action of these three-phase currents is to produce travelling polarities along the row of poles, and induce electromotive forces in the coils wound around the portion of the core above the six pole-faces. This winding, it will be observed, is electrically the precise equivalent of a Gramme ring. In an ordinary Gramme dynamo the ring revolves between two poles. Here, instead, the two polarities travel past the re-entrant winding. Under these circumstances, seeing that the commutator stands still, it is necessary that the brushes should be rotated synchronously in order that they may collect the continuous current. An apparatus essentially upon this

* The number of square inches of peripheral surface per kilowatt of output gives a basis for estimating to what degree in the design of an armature the specific utilisation of its materials has been carried. Modern dynamos of over 100 kilowatts output have from 4 to 12 square inches per kilowatt. Old machines and small machines vary from 10 to as many as 25 square inches per kilowatt. In this estimate the working part only of the peripheral surface is counted, being the length round the periphery multiplied by the total (gross) thickness of iron parallel to the shaft. These values apply to alternators and motors as well as to continuous current dynamos.

* This cut is reproduced, by the courtesy of *Engineering*, from the description given in that journal of the Central London Railway.

principle was patented * by Zipernowsky and Deri in 1888, the brushes of this machine being rotated by a synchronously revolving unwound field magnet. How sparking was obviated does not appear. A further development in permutating machines was made by Messrs. Hutin and Leblanc, who turned the difficulty of the revolving brushes by the following device:—Upon the shaft of the synchronous motor is fixed the commutator and a series of slip rings equal in number to the bars of the commutator, so that, though the commutator revolves, each segment may still be in connection with its corresponding point on the stationary re-entrant winding. The brushes may then be fixed as in ordinary machines. In *L'Electricien* of April 21st, 1894, a detailed account is given by M. Aliamet of the further ideas of these inventors. It appears that 18 slip rings are necessary in practice. A further account of an installation at Epinay is given by M. Guilbert in *La Lumière Electrique* of June 16th, 1894. The sole advantage of machines of this type seems to be that they can transform and convert the three-phase currents from a high voltage without requiring the interposition of any other transformer. Their disadvantage in requiring many slip rings is obvious. It is also very doubtful whether under varying conditions of use the sparking would not be excessive. Nevertheless, this type of converting machine is well deserving of the further attention of engineers. Probably there are cases where it is to be preferred to either the motor-dynamo group or the rotatory converter proper. The motor dynamo can transform the voltage as well as change the species of current. The converter can change the species of current, but only by adopting a fixed ratio of voltages. As it is inexpedient to operate a commutator at voltages over 1,000, the converter cannot be used in conjunction with a high voltage polyphase transmission except by the addition of a step-down polyphase transformer. It then becomes a question whether it is cheaper (regard being had to efficiency of operation as well as the prime cost) to instal the converter with the step-down transformer, or to substitute a pair of coupled machines as motor dynamo. Experience shows that, at any rate in cases where the frequency of the supply is already sufficiently low, the former is generally the more economic. But it is quite probable that there are cases where the economic conditions of the problem may point to the permutator as affording a solution preferable to either motor-dynamo or converter.

* Specification No. 12,856 of 1888.

matter from the plates to collect. The plates are connected by lead strips. To prevent short-circuiting the battery is mounted on a hard rubber trough, and air spaces are provided on all sides for cooling. To prevent noxious fumes entering the car the batteries are so ventilated that the forward motion of the car causes a current of air through the boxes and carries the gases off, and upward. To prevent spilling the acid by reason of the jolting of the car, the cells are covered with soft rubber sheets, and a drain is provided to carry away any acid that may be spilled, so that it cannot strike the truck or rails. The battery complete weighs, according to the state of the plates, from 4,400 to 5,500 lbs.

The batteries are at definite intervals subjected to a very simple but sufficient inspection. When the cars are brought into the car house at night, the batteries are charged to the point of developing gas, but care is taken not to sulphate the plates, and at the same time any damage that may have happened during the day is repaired.

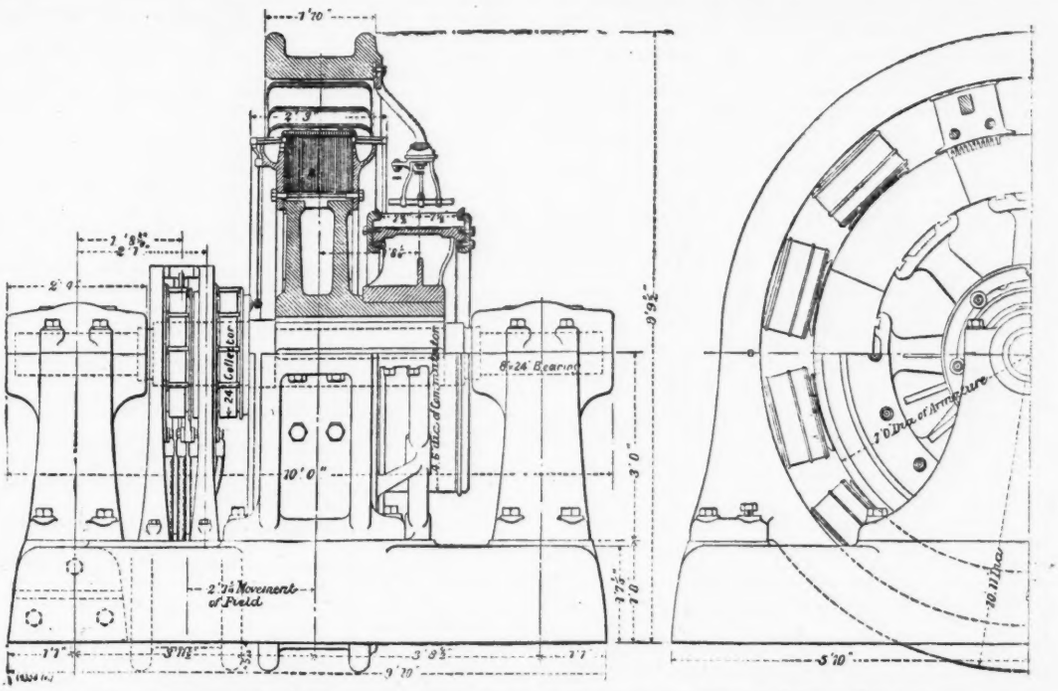


Fig. 15.—Three-Phase Converter, designed by Mr. Parshall for Central London Railway.

ACCUMULATORS AT HANOVER.†

The accumulators are placed under the seats and comprise 202 elements in hard rubber cells, with a capacity of 25 ampere-hours at a discharge rate of 25 amperes. Each element consists of one positive Planté plate with an area of 13·17 square inches, and two negative plates each of which has ·66 lb. active material. The plates are separated by glass tubes or hard rubber strips. Below the plates is a space ·16 inch in depth to allow the slime and disintegrated

When charging, the loss due to evaporation is made good by adding the necessary amount of water; each day about one-third of the motor cars have water added to the batteries to make good the loss by evaporation. Each week the voltage of every element is taken, and if found low the cause, which is usually a small short circuit, is removed. If at the next weekly inspection the element is still out of order, which, however, is seldom the case, it is cut out and thoroughly repaired, being replaced by a new one from a battery in reserve.

Also each week the battery is inspected as to the accumulation of sediment, acid density, polarisation, breakage of tubes, cracking of cells, &c. Also the means of ventilating the cells and the acid drain pipe are looked after. This nightly work upon 70 cars is done at our Glocksee station by three men.

After running from 8,000 to 12,000 kilometres (5 000 to 7,500 miles), the distance varies on the different lines according to the demands made on the battery and the time during which it is charging from the trolley wire, the acid is pumped out, the glass tubes separating the plates removed and the sediment washed out. If the specific gravity of the battery fluid after this time is found reduced, chemically pure sulphuric acid is added to bring it up to 1·21 again. After the battery has been again charged a capacity test is made in order that it may be known whether it can be best used on a route requiring light or heavy service until the next general cleaning. When the capacity has dropped to 12 ampere-hours, with a 25-ampere discharge rate, the battery is put in service on the light lines where only from 4 to 8 ampere-hours are needed and used until it is to be again cleaned. At this cleaning the batteries are fitted with new plates. The positive plates that are yet fit for use are changed to older batteries, and those that cannot be used sold for the value of the lead.

The negative plates are freed from the old paste which has been reduced to metallic lead, and new paste provided. They are then as good as new and are again placed in cells. This "repasting" can be continued until the plate fails from mechanical causes.

The grid is made to last through six "re-pastings," or about 240,000 battery driven kilometres (150,000 miles).

The cost of filling the negative plates with the new paste is 76 marks ($18.22) per car. The new positive plates cost 707 marks ($169.55) per car.

From August 1st, 1896, to August 1st, 1898, the cost for maintenance and renewals of the batteries has been, in spite of

† Abstracted by the *Street Railway Review* from a paper presented at the Geneva meeting of the Permanent International Tramway Union by Theodore Kruger, director, Hanover.

unfavourable relations between the battery mileage and the trolley mileage, only 2·093 pf. per automobile kilometre (·81 cent per car mile).

The several routes are as follows:—

	Trolley miles.	Accumulator miles.
1	6·87	2·47
2	2·60	1·55*
3	3·28	1·68
4	2·46	1·65
5	2·36	3·07*
6	1·36	1·06
7	2·40	1·82*
8	1·41	2·59*
9	·59	2·05*
10	—	10·93
11	·71	11·07
12	6·07	—
13	6·40	—
14	2·38	—

Those distances marked * are covered twice, that is, one round trip, without recharging the battery.

The life of the batteries depends solely upon the treatment and extent of the regular discharges. Aside from this, the time of charging, upon which depends the strength of the charging current, is extremely important. With a positive plate of 85 sq. cm. area, such as used in Hanover, and charged with a current of 150 amperes for 10 minutes after a previous complete discharge, the longest life that could be expected is 20,000 automobile kilometres (12,400 car-miles). The negative plates under the same conditions would at best have a life of 18,000 automobile kilometres (11,178 miles), as they would not have the necessary capacity to carry the load at the full discharge rate.

If it is desired to increase the life of the battery, in fact nearly to double the life, it should be chosen large enough so that not more than one-half of its capacity will be needed, and care taken that the ratio of the charging time to the discharging time is at least as 1 to 2. If it be made longer the results will be better. It is believed that under these conditions a life of from 35,000 to 45,000 kilometres will always be obtained.

Notwithstanding that in the beginning the conditions were very unfavourable as to the time available for charging, the life of the batteries was 37,700 kilometres.

The average life of the batteries in 37 cars was 37,708 kilometres (23,417 miles).

The average life of the positive plates in seven cars was 39,497 kilometres (24,528 miles).

The average life of the negative plates in two cars was 37,554 kilometres (23,321 miles).

But favourable conditions as to the time of charging and discharging are of no avail if the inspection is not sufficient and above all if the cleaning (removal of sediment) is neglected. The current loss that usually occurs under these circumstances will ruin the whole battery in a short time; and when under favourable conditions the life of the batteries is short, it is believed that the reason is lack of sufficient care.

The best demonstration of this is the fact that the life of stationary batteries is variously reported at from one to 12 years.

It has been definitely determined by measurements that the average charging current, for a discharged battery with a potential of 2·4 volts per element, is 36 amperes; when the batteries were charged the charging current was still about 1·7 amperes. A motor car weighing 10·5 tonnes (11·55 short tons), including the load, required, when taking current from the trolley wire, 554 watt-hours per kilometre (892 watt-hours per mile). When driven by the battery the same car required 533 watt-hours per kilometre (858 watt-hours per mile). The loss in charging the battery is taken to be 20 per cent. more, making the total 640 watt-hours per kilometre (1,030 per mile). A car weighing 10·4 tons and drawing a trailer of 4·38 tonnes, a total of 14·78 tonnes (16·26 short tons) required 614 watt-hours per kilometre (989 per mile) by trolley, and 564 by battery traction; adding 20 per cent., makes the total for battery traction 676 per kilometre (1,088 watt-hours per mile). When the loss in the transmission from the generator to the car is included, the energy consumption per tonne-kilometre is, at a high estimate, not more than 70 watt-hours (102 watt-hours per ton-mile). The battery weighs, say, 2·5 tonnes (2·75 short tons), and to propel this weight requires 175 watt-hours per car-kilometre (280 watt-hours per car-mile). In Hanover, where the accumulators serve as regulators for the station as well as to propel the cars, the cost of energy (not including depreciation) is 1·2 cents per kilowatt-hour. (From this it would appear that the excess of cost of power for motor car-mile is about ½ cent when the batteries are in use, and ¼ cent when not in use, over what the cost would be with a simple overhead trolley.—Ed.) What the conditions would be in other cities cannot be stated.

In the course of the next year numerous changes will be made which will increase the economy of operation. Arrangement will be made for the company itself to "re-paste" the plates, thus saving the manufacturer's profit and the freight charges. The acids will be made by the company reducing the cost 50 per cent. An automatic distilling apparatus is to be installed, dispensing with two men. The old plates will be cast into new ones and thus utilised to better advantage. There is produced annually some 20,000 kilograms of peroxide of lead, which will be purified and dried so that it will bring $15 per 100 kilograms instead of only $3, as heretofore. By substituting a benzine lamp for soldering, instead of using a hydrogen flame, which is possible by the use of a new composition, a considerable saving of time and money will be effected and equally good joints made.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

25,051. "Improvements in or relating to combined pressure or vacuum registers and electric alarms." C. A. GILLESPIE. Dated November 28th.

25,058. "The spring automatic fuse replacer for electrical cut-outs." H. G. SOLOMON. Dated November 28th. (*Complete.*)

25,084. "Improvements in phonographs, graphophones, and the like." L. WOLFF. Dated November 28th.

25,087. "Improvements in arc lamps." W. CRUDGINGTON. Dated November 28th.

25,095. "An improved flexible conductor for submarine cables." G. G. M. HARDINGHAM. (The firm of Felten & Guilleaume, Germany.) Dated November 28th.

25,098. "Improvements in electric surface contact tramways." S. P. THOMPSON. Dated November 28th.

25,109. "Improvements in electric hoisting machinery." J. W. BROWN and A. J. G. SIMPSON. Dated November 28th.

25,202. "Improvements in electric alarm clocks." L. SCHOTT. Dated November 29th.

25,217. "Improvements in and relating to the production of electric currents." R. ECHTERMEYER. Dated November 29th. (*Complete.*)

25,221. "Improvements in electric arc lamps." J. J. RATHBONE. Dated November 29th.

25,259. "Improvements in electrical revolution indicators." K. OBST. Dated November 30th. (*Complete.*)

25,260. "Improvements in electricity meters." H. NUNNS. Dated November 30th.

25,314. "Improvements in apparatus for transforming alternating into continuous electrical currents and conversely." C. D. ABEL. (La Societe Anonyme pour la Transmission de la Force par L'Electricite, France.) Dated November 30th.

25,327. "An improved electrical terminal." L. RIDOUT. Dated December 1st.

25,410. "Improvements in batteries or apparatus for producing ozone." C. A. SAHLSTROM. Dated December 1st.

25,417. "A switch for electric circuits." J. ECK. Dated December 2nd.

25,479. "Electric igniter or sparker for gas, oil, or vapour engines." F. W. CANFIELD. Dated December 2nd. (*Complete.*)

25,537. "An improved contact device for electrical igniting devices of gas engines." W. P. THOMPSON. (Firm of Bluhm & Co., and J. Bauer, Germany.) Dated December 3rd.

25,567. "Apparatus for transmitting motion to a distance by means of electrical energy." SIEMENS BROS. & CO., LTD. (Siemens and Halske Aktiengesellschaft, Germany.) Dated December 3rd. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9d. (*in stamps*).

1897.

9,387. "Improved means for lighting by electricity and incandescence." J. A. SINCLAIR. Dated April 13th, 1897. Relates to incandescent lamps. An incandescent carbon or other conductor is surrounded by a thin hood of magnesia or other like oxide made as described in specification No. 28,101, of 1896, and enclosed in a highly exhausted bulb, the residual gas being air. The conducting filament may be a tube closed at one end, and divided by two or more slots to near the closed end. It is made from moulded cellulose; or two strips of paper may be curved to form the limbs, and connected by another strip cemented round their other ends. The ends of the filament are cemented to curved parts of leading-in wires, which are connected by a glass rod. A magnesia disc is also cemented on the curved parts of the wires. The hood is made somewhat larger than the filament, and is secured by cement on the wires. It may be supported at the top by a central rod of magnesia, carried by a central wire on the glass rod, or by an inner magnesia tube, open at the ends; these arrangements permit the hood to be very thin, but it must be opaque. 7 claims.

12,758. "An improved form or construction of pipes for the reception of electric cables." J. J. GREEN and W. OATES. Dated May 24th, 1897. To enable cables to be drawn through conduits not laid accurately in line, the bore of the conduit is made oval, the longer axis being vertical. 1 claim.